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PRINCIPAL INVESTIGATOR: Barbara Abrams, Ph.D.

CONTRACTING ORGANIZATION: University of California at Berkeley
Berkeley, California 94720-5940

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6. AUTHOR(S)
Barbara Abrams, Ph.D.

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
University of California at Berkeley
Berkeley, California 94720-5940

E-MAIL:
barbara@violet.berkeley.edu

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13. ABSTRACT *(Maximum 200 Words)*

We have completed recruitment, data collection and data entry for this study group of new mothers attending the well-baby clinic at the Naval Medical Center, San Diego. We enrolled more than 2500 eligible women and obtained essential data from 1652 of them. Data on the major endpoint, maternal weight late in the postpartum year, are available for more than 1600 of these women, and longitudinal data, reflecting weight measures during the early, middle and late periods of the postpartum year, are available for 861 women. Approximately 20% of the study participants are active duty women.
Women in this study, on average, retained more weight late in the postpartum year than usually reported (about 4 kg in this study compared to means of 1.5 to 2 kg in previous studies). Approximately 25% of women who began pregnancy with normal BMI became overweight after birth; the prevalence of overweight was even higher among certain subgroups. Results so far suggest some social, demographic and behavioral risk factors that appear related to increased postpartum weight retention in both active duty and dependent mothers. Additional analyses in the coming year will contribute more information on factors and behaviors that may increase, or protect against, maternal obesity after pregnancy.

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INTRODUCTION

Maintaining physical readiness to meet demands of combat conditions is of utmost importance for active duty military personnel. All branches of the military assess body size as a major indicator of fitness. During the last 20 years, the number of women on active duty in all services increased almost five-fold, from 2.5% in 1973 to 11.5% in 1992. As growing numbers of women of childbearing age enter active duty military service, the numbers of pregnancies among female military personnel will also increase. Thus, understanding the impact of pregnancy on subsequent fitness of postpartum active duty women becomes imperative.

During an average successful human pregnancy, the mother increases her body weight by 20% or more. There is strong and consistent scientific evidence that this weight gain plays an important role in ensuring a healthy infant. However, relatively few studies have addressed maternal weight loss after delivery and none have been conducted in populations of military women. Nonetheless, military women are required to return to active duty 6 weeks after delivery, in good physical condition and in uniform. Although studies in civilian populations suggest that it may take as long as a year to return to prepregnant body size,(1, 2) women in the military are expected to achieve weight and fitness standards much sooner than this: in the Navy and Marine Corps they are required to achieve weight and fitness standards within 6 months after delivery; the Army exempts women from standards for "the period of convalescent leave after birth," and the Air Force expects compliance by 3 months after delivery. Rehabilitation (comprised of a low fat diet and exercise regime) is required of women who fail to meet these standards, and if women remain outside acceptable ranges, they are subject to discipline or dismissal.

Yet, despite a body of previous research, the "normal" pattern of postpartum weight gain and risk factors for postpartum weight retention remain poorly understood. Without a clear understanding of the cause of weight retention, it is impossible to design effective strategies for intervention.

Background

Maternal weight retention after birth A 1990 Institute of Medicine (IOM) report concluded that, after considering weight increases due to age and given an average maternal weight gain during pregnancy, average permanent weight retention is about 1 kg per pregnancy.(5) Recent studies are consistent with this estimate, reporting the average mother retains about 1.5 kg (3.3 pounds) of her pregnancy weight gain(1,2,6), although several report values as high as 3.8 kg (8.4 lb) at one year postpartum.(7,8) A comparison of 18-30 year old women who had been pregnant with those who had not over a 5 year period concluded that primaparas gained, on average, 2-3 kg more weight than nulliparas.(9)

However, focusing on the average weight retention can obscure important differences in subgroups. For example, median weight retention at 10-18 months after delivery was only 3.4 lb in the 1988 National Maternal Infant Health Survey (NMIHS), a national sample of 2845 US. women, but 25% of white women and 40% of black women retained more than 9 lb.(6) Similarly, in a study of 1423 Swedish women, after controlling for weight change with age, average weight retention at 1 year postpartum was only 0.5 kg (1 lb) but the frequency of overweight women increased from 13% before pregnancy to 21% postpartum.(1) Thus, studies of maternal weight retention must assess not only the experience of average women, but also provide information on subgroups, for example, by race, prepregnant size, or breast feeding status.

Because of fluid adjustments that occur immediately after birth, most women lose weight quickly until two weeks postpartum, and then the rate of weight loss levels off.(5) Among mostly middle class white mothers who delivered in Wisconsin, fewer than one-fourth had returned to their pre-pregnancy weights by 6 weeks postpartum,(2) and mean weight retention at 6 weeks was 4.5 kg in 400 Illinois women.(8) Furthermore, in the Wisconsin study, only 37% of the women had returned to their prepregnancy weight by 6 months after delivery. These data indicate that maternal weight is not lost immediately after pregnancy, and additional research is needed to describe both average loss and its distribution throughout the first year after delivery.

The strongest factor contributing to weight changes postpartum is prenatal weight gain.(1,2,5,6,8,10-13) For example, our multivariate study of the 1988 NMIHS found that women with normal prepregnancy body size who gained above 35 pounds (the upper limit of the current IOM recommendation for prenatal weight gain in normal weight women) were over twice as likely to retain 20 or more pounds postpartum than those who gained within the IOM guideline of 25-35 pounds.(11) This increased risk was present for both white and black mothers and persisted after adjustment for various maternal characteristics. Postpartum weight retention in this population was relatively low among white mothers who gained within the IOM recommendation, suggesting that current prenatal weight gain guidelines may provide some protection against postpartum obesity for these women.(6,11)

Since black mothers, on average, gain less weight during pregnancy than white mothers,(5) one would expect that black mothers would retain less after delivery. However, data from the 1988 NMIHS survey indicate that black mothers retain on average more weight than white mothers.(6) This difference persists regardless of prepregnancy body size or prenatal weight gain. Furthermore, in our multivariate study of NMIHS participants with normal prepregnancy weight-for-height, black mothers were over twice as likely to retain 20 or more pounds postpartum than white mothers.(11) This difference remained after adjustment for maternal age, parity, prenatal weight gain, infant birth weight, height, prepregnancy body size, marital status, and social class. Other recent studies reported similar findings.(9,13) We identified no published data on postpartum weight change in mothers who were Hispanic, Asian or other races. Additional research is clearly needed to determine factors that influence maternal weight loss after delivery by race.

Encouraging individuals to increase their physical activity is a hallmark of weight management, but little is known about the impact of recreational or occupational physical activity in relation to maternal weight loss after delivery.(13) In a Swedish study, women who retained excess weight postpartum reported low levels of recreational physical activity during the year after birth, and increased physical activity was correlated significantly with postpartum weight loss.(14) In another small study of exclusively breast feeding women, maternal weight loss did not differ for mothers who undertook regular aerobic exercise between 6 and 18 weeks postpartum, compared to those who did not, although exercising mothers became more physically fit than their non-exercising counterparts.(15)

Little is known about the prevalence or impact of dieting during the postpartum period, for either lactating or non-lactating mothers.(14) Results of a Swedish study suggested that intentional dieting was associated with increased weight loss, while certain dietary practices (e.g., increased meal size, increased snacking, meal skipping) were associated with excessive weight retention.(15) Dieting is of special concern to women who breast feed, because while there appears to be little or no relationship between moderate changes in energy intake and milk volume, there is some evidence that a threshold exists under which the quality and quantity of breast milk may be compromised.(14)

Cigarette smoking, which is a major risk factor for poor health in general and during pregnancy, is protective against excessive weight retention postpartum.(1,2) In fact, the highest risk of weight retention may occur in mothers who quit smoking during pregnancy and do not resume postpartum.(1) This observed benefit of smoking does not offset the toxic effects of cigarettes on the health of both the mother and her baby.

New mothers are commonly told that breast feeding will accelerate their weight loss after birth. The basis of this advice is the assumption that fat stores gained during pregnancy are mobilized to subsidize the energy cost of lactating. However, while some studies suggest that breast feeding women lose weight faster than bottle-feeding women, many do not.(2,3,8,10,11,16-18)

Wider variations in weight change postpartum are observed in women who begin pregnancy overweight than in lighter women.(1,10) There is also evidence that women with a history of weight cycling and dieting are more likely to retain excessive amounts of weight after pregnancy.(1, 19)

There is consistent evidence that women with lower income and lower education may have an increased risk of retaining more weight postpartum than women with higher socioeconomic indicators.(8,11) It is likely that socioeconomic differences are based on lifestyle behaviors and environmental circumstances. Other important risk factors for excessive postpartum weight retention include maternal age, parity, interpartum interval and maternal work outside the home. For these variables, study results are not consistent, suggesting the need for additional research.(20) Furthermore, the importance of adequate

help and social support during the year after delivery to maternal weight changes, especially for those mothers working outside the home, has not been studied.

As previously discussed, maternal weight gain during pregnancy is an important risk factor for excessive postpartum weight retention. This implies that restriction of maternal weight gain during pregnancy might be a useful strategy to promote a quicker maternal postpartum weight loss. However, maternal weight gain during pregnancy is an important determinant of fetal size at delivery, which in turn is the most important predictor of survival and health of the newborn.(5) Reflecting this relationship, current recommendations for maternal weight gain during pregnancy are higher than ever before, especially for women who begin pregnancy at or below ideal weight for height.(5) Thus, although the major focus of this study is maternal weight after delivery, the birth weight of the infant must also be considered.(21) Furthermore, the pattern of maternal weight gain during pregnancy may play a more important role in fetal outcome than the total amount, although only a few studies have examined this issue. We have recently published a multivariate analysis of almost 3000 white women which suggests that, even when total maternal weight gain at delivery is held constant, a low maternal weight gain during the second trimester is associated with a significantly smaller infant.(22) Thus, maternal weight gain pattern appears to relate to infant birth weight, and it is also likely that the pattern of maternal weight gain may relate to postpartum weight retention. Several epidemiological studies have attempted to quantify levels of maternal gestational weight gain that promote fetal weight while reducing excessive maternal weight retention after delivery. One study concluded that for women who gain excessively, there is a "point of diminishing returns in birthweight at the expense of increasing maternal obesity."(23) Another concluded that "excessive gestational weight gain before 20 weeks gestation was associated with increased postpartum weight retention, especially for well nourished, overweight women."(24) A third study concluded that, in women with normal prepregnancy weight, excessive gestational weight gain did not greatly enhance fetal growth but did increase the risk of postpartum overweight.(12) However, none of these studies were able to examine factors related to maternal weight gain during pregnancy or behavioral predictors of maternal postpartum weight.

Study objective and design

This project, "Postpartum Weight Changes: Implications for Military Women" is referred to in the rest of this report as the "ABC Study". It addresses the question "how long to allow for returning to weight and physical fitness that meet service standards" found on page 39 of the Institute of Medicine's 1995 report Recommendations for Research on the Health of Military Women. The same issue falls under Physical Standards Linked to Occupations, "The scientific basis for physical standards" on page I-6 of the September 15, 1995 Broad Agency Announcement for Defense Women's Health Research.

The major objectives of the study are to:

1) describe the pattern of weight loss during the first year after delivery in a large study group of active duty and military dependent women,

2) compare differences in weight loss by maternal characteristics, and
3) identify characteristics of women who are most likely to become permanently overweight or obese as a result of childbearing.

A detailed description of the study methodology is included in the 1998 Annual Project Report. The ABC Study was integrated into the Pediatrics Clinic at Balboa Hospital at the Naval Medical Center, San Diego (NMCSD). The study has two components: a series of cross-sectional slices at 3 days (0.1 month), 14 days (0.35 month), 2,4,6,9 and 12 months, and a smaller longitudinal cohort. Some women in the study provide data at only one or two points of time (for example if enrolling at the end of the first postpartum year, or if entering or leaving the facility due to transfer, deployment, or separation). We intentionally selected the sequential design to accommodate routine military operations by which personnel are transferred, on average, every 3 years. If we had utilized a strict prospective cohort design, we could automatically lose at least one-third of our cohort before completing follow-up. By defining our study groups according to infant age, data from women who are transferred can be utilized for the periods they participated, and new data from recent transfers can also be added to the study. In this report, we present results on the cross-sectional analyses as well as analyses of data from women who contributed data throughout the postpartum year.

Variables Studied

Data for this project were collected from 3 different sources: 1) Measurements of weight (and one height measurement) during clinic visits, 2) Clinic and Take-home Questionnaires, and 3) Medical Record Abstraction.

Weight and Height: Maternal postpartum weights were measured at each clinic visit on a calibrated, digital scale. The mother wore light clothing and no shoes. Each mother was weighed twice, and if the two weights disagreed by more than 0.1 kg, the mother was weighed a third time. Maternal height was measured at the first visit using a stadiometer. Height was measured at least twice to ensure accuracy. All enrollment measurements were collected by trained study staff while the majority of the follow-up measurements were taken by clinic corpsmen who were formally trained to follow specific protocols. A quality assurance protocol was in place. A study staff member re-checked the accuracy of each person taking measurements on a routine basis and then provided retraining as needed. At the request of our collaborating pediatricians, we also recorded and entered infant weight, length and head circumference at each visit.

Questionnaires

We collected data using the following questionnaires:

- 3-7 Day Clinic Questionnaire: A short questionnaire consisting of ~8 questions given only to mothers enrolled at the 3 day weight check. We intentionally kept this instrument brief to minimize participant burden.

- 10-16 Day Clinic Questionnaire: A slightly longer questionnaire (~30 questions) given only to mothers at the 2 week well-baby check.

- 2-12 Month Clinic Questionnaire: This questionnaire was self-administered at each well-baby or non-urgent care appointment beginning at 2 months postpartum . Although it consists of ~ 50 questions, most women easily completed it in about 10-15 minutes.

- The Baseline Questionnaire: This questionnaire was intended to be administered at home at 2 months postpartum or whenever the mother enrolled if her baby is older than 2 months of age. It asked questions about family history, prenatal weight gain, smoking, physical activity, dieting practices and work during and after pregnancy and sociodemographic data. Depression and body image scales covering the previous seven days were also included. This questionnaire was lengthy and relatively demanding in scope.

- The Follow-up Questionnaire: This questionnaire was intended to be administered at home at 12 months postpartum. It asks women to reflect upon the past year in relation to their work, physical activity, dieting behavior and infant feeding practices, etc. It also includes a depression scale for the previous seven days. This questionnaire was lengthy and relatively demanding in scope.

- The 12 Month Enrollment Questionnaire was designed specifically for women who enrolled at the 12 month visit. It replaces the Baseline and Follow-up Questionnaire by combining the most relevant questions from each. This questionnaire was also sent to women who enrolled earlier in the study, but never returned a baseline questionnaire. This questionnaire was lengthy and relatively demanding in scope. It was also administered at home.

- Mini Follow-up and Mini 12-Month Questionnaires were designed after we left the field to facilitate collection of final data from women who had not completed the study, either due to the age of their infants when we left the field or non-response. These questionnaires contained a subset of the most important questions from the full versions of the Follow-up and 12 Month questionnaires, however they required much less time to complete.

Questionnaire Content

As cited in the background section, many studies have examined postpartum weight loss, but most have limited their explanatory variables to a few factors, such as maternal age, parity, race, infant feeding method and prenatal weight gain. In most of the studies, even these few variables have been measured in rather crude ways, leaving many questions about the nature of the relationships analyzed. A few have measured physical activity or work in a cursory way. To our knowledge, the only study to collect data on weight history and dieting practices was in Swedish women. Except for this Swedish study, we are aware of no large studies that have simultaneously addressed a large array

of factors that may influence postpartum weight. Thus, a major strength of the ABC Study is its comprehensive assessment of a wide range of social, prenatal, psychological and lifestyle variables. The breadth and depth of the information we are collecting increases the potential that, unlike previous studies, when we find an association between a specific exposure and postpartum weight, we will be able to explain the relationship. Appendix B of the 1998 report contains a copy of the 2-12 month Clinic and Baseline Take-home questionnaires (other questionnaires are available upon request).

1) Depression: was measured using the Center for Epidemiologic Studies-Depression Scale (CES-D) because it was validated in the scientific literature (25) and it was used in other large recent studies of women (the National Institute of Aging's SWAN: Study of Women Across the Nation study, WIHS: Women's Interagency HIV Study, funded by several institutes within the National Institutes of Health, and the Centers for Disease Control's HERS: HIV Epidemiology Research Study). This instrument consists of 20 short questions that are easy to understand and are easily self administered. We considered scales designed specifically to measure postpartum depression, particularly the Edinborough Postnatal Depression Scale (26), but decided that the CES-D was a more useful assessment of mood for this population. We hypothesize that depression will be associated with excessive weight retention in some women and excessive weight loss in others.

2) Lactation: To measure intensity of lactation, we developed an infant feeding question for the clinic questionnaire. It was based upon the recommendations by the Institute of Medicine.(27) Our question differentiates between exclusive breast feeders, formula feeders and levels in between these extremes: partial and token breast feeders. Questions about other foods and juices fed to the baby were also included in the clinic questionnaire. To measure duration of breast feeding, we also included questions in the 12 Month Follow-up questionnaire to determine when mothers began to wean their infants and stopped breast feeding completely. We also investigated the barriers to breast feeding and the reasons women stopped. The series of possible responses compiled from other studies (28) served as the basis for this question.

3) Body Image: We conducted an extensive review of the literature addressing measurement of body image perceptions and identifying people with eating disorders. Because many of the questionnaires were outdated or extremely long and detailed, we chose to develop 4 very short questions about weight, shape, eating and appearance that generally measure the amount of time a mother thinks about these issues, using the same response categories in the CES-D (depression) scale.

We also chose to include a set of 9 silhouettes of women ranging from quite thin to very obese. These silhouettes have been validated in the literature (29) and have been used successful to measure body image of pregnant women.(30)

4) Dieting Practices: We compiled an extensive list of dieting practices based primarily upon questions utilized in the National Center for Health Statistics studies and other sources.(31,32)

5) Physical Activity: We worked very closely with our consultant exercise physiologist to develop a combination of validated scales to measure current overall activity and work-related activity.(33-38) These questions were then adapted to reflect recalled physical activity during pregnancy.

6) Active Duty Women: After meeting with active duty women (both postpartum mothers participating in our pre-tests and female pediatric staff), we developed a series of questions related to physical readiness test concerns and physical training requirements. These data should be useful in determining whether certain occupational practices, such as required PRT, are associated with more successful return to prepregnancy weight.

7) Social Support/Deployment/Spouses/Emotional Issues: We developed a series of questions to estimate social support because we did not identify a useful source of published questions after consulting with expert psychologists here at UCB. To our surprise, during the pretest, women universally stressed the importance of measuring spousal deployment as a potential factor in maternal postpartum weight. Therefore, we added questions to measure the duration of paternal deployment during the baby's first year. We also have included questions on self-perceived stress and infant health problems as we suspect these factors may influence changes in maternal body weight.

7) Dietary Intake: The Health Habits and History Questionnaire (HHHQ-Block) is a semi-quantitative food frequency instrument developed and validated by Gladys Block at the National Cancer Institute and here at Berkeley. This self-administered questionnaire is highly respected and used in numerous studies throughout the United States to measure diet and health.(39) We included it to assess dietary intake during the 6-12 months postpartum period. However, this questionnaire was time consuming, and when we determined that the response rate to the Follow-up questionnaire was lower than expected, we removed the food frequency instrument. We intend to analyze the data for the more than 181 women who did complete it.

Medical Record Abstraction

The goal of medical record abstraction in the ABC Study was to collect information from the medical records of participants regarding their prenatal course and delivery. This information:

1) Provides demographic data,
2) Allows calculation of the gestational age of the infant at the time of delivery,
3) Allows calculation of the total weight gain and pattern of weight gain during pregnancy for the mother and
4) Provides information regarding the type of delivery, complications, and birth weight of the infant(s).

We are using these data to examine the relationship between prenatal, labor and delivery factors and the health and fitness of mothers in the first year following the delivery.

Appendix C of the 1998 Annual Report contains a copy of the Medical Record Abstraction Form.

To obtain data from the prenatal records, we obtained informed consent to abstract medical records at Balboa Hospital, and other records from other hospitals which were then abstracted onto our standard form by a trained staff.

The entire medical record abstraction process was managed by the MRA database at UCB which tracked the progress of ordering, obtaining and successfully abstracting each record. The coded Medical Record data were then sent to our outside vendor for key entry. All copies of medical records are currently stored in locked cabinets to preserve confidentiality, and all will be destroyed at the end of the analysis phase of the study.

Data Analysis

During data collection, all raw data entry was originally contracted to FSC, the subcontractor who performed the field work enrolling participants and collecting the data in San Diego. Because FSC did not satisfactorily fulfill the data entry portion of their contract, we hired a different subcontractor (Optimal Data Systems in Sacramento) during the 1999-2000 academic year to re-enter all data. Although this company was contracted to double-key and verify all data, once the file was transferred to Berkeley, we noticed an unusual number of impossible values. When we compared the keyed data to the raw data in questionnaires, it became apparent that the data had not been properly keyed. Therefore, we voided the contract with Optimal Data Systems and subcontracted with a third firm, Richardson Data Services, who satisfactorily completed the process of double-key and verified entry of all study data at the end of 2000. We then cleaned selected variables from the now properly-keyed data and attempted to reconcile results of the current anayses with those analyzed previously. Several issues reported in the 1999 report have been corrected that allow for a fuller interpretation of the data. Specifically, there is less variation in the data and data that were missing on height for a substantial proportion of the women at the time of the last report have been recovered. In addition, the data in this report are more complete, reflecting all collected information through December, 1999, when the study left the field. However, we have only had access to the fully entered data for 2 months and we are continuing to examine and clean the vast number of variables, some of which influence the composition of the analytical sample. Thus, all analyses presented in this report are still to be considered preliminary.

Study data are being analyzed by the research team at UCB. The data analysis plan has not changed from that described in the original proposal.

Progress in Terms of Technical Objectives

In the following section, we list each technical objective (shown in bold type) and describe our progress and relevant research results.

- Task 1: **Hold advisory meeting. Finalize protocol, hire staff, field-test data collection methods. Begin recruiting women.** Except for the advisory meeting, these tasks are complete. We have chosen to delay a formal meeting with our Advisory Committee until we have sufficient data to share with them. However, we have contacted some members of the Advisory Committee for expert input and responses to our questionnaires/data collection procedures on an individual basis and will continue to do this.

- Task 2: **(proposed months 4-28)**
  a. **Collect data on 4000 women during the first year after birth. Recruit subjects, collect postpartum maternal weight measurements and questionnaires. Edit, code and enter data.** This task is complete.
  b. **Obtain/abstract prenatal medical records, enter data.** This task is complete.
  b. **Create a preliminary analytical data set by merging these data sources. Clean/edit data. Using this preliminary data set, begin programming data analyses for tasks 3-6.** Creation of the preliminary data set is accomplished. Preliminary analyses are reported. As noted above, all data have been double entered and final reconciliation of entered and re-entered data will be complete this quarter.
- Task 3: **Use parametric techniques to summarize the sequential measurements to provide estimates of the overall pattern of maternal weight gain during pregnancy and the pattern of maternal weight loss after birth. (proposed months 18-29).** As noted below, longitudinal data analyses have been conducted describing the impact of various independent variables on postpartum weight change. Further analyses will be conducted to examine all measured weights from the maternal obstetrical records to summarize the pattern of prenatal weight gain and to all measured well-baby clinic weights to summarize postpartum weight loss. This task will be completed within the next academic year and included in the 2001 Annual Report.

Tasks 4-9 (proposed months 26-46): **Use multivariate statistical methods to**

- **describe the postpartum weight loss pattern and prevalence of excessive weight retention at 2 weeks, 2,4,6,9 and 12 months after delivery, by military status, race and other maternal characteristics, comparing results using several definition of postpartum weight retention. (proposed months 18-29)**
- **test the hypothesis that a high maternal weight gain during pregnancy, especially during the first and third trimesters, will be associated with excessive maternal weight retention, after adjusting for potentially confounding variables including military status, and risk factors.**
- **Using bivariate and multivariate statistical models, examine how maternal circumstances (e.g. education, socioeconomic status, marital status, work, social support), and lifestyle behaviors during the postpartum period (including method of infant feeding, reported physical activity, dieting behavior, attitudes toward body size, work hours, sleep) relate to maternal change and excessive weight retention.**

- **Use the results of previous analyses to attempt to identify those women who are most likely to become overweight as a result of childbearing, and to identify when postpartum (or during pregnancy) such women might be detected.**

We have made substantial progress in addressing these tasks as described below.

Description of analyses conducted

Description of the study population

Analyses were conducted to determine the effectiveness of study recruirment and to describe the amount of follow-up data collected. This analysis is presented as a detailed flow chart shown in Figure 1 and described later. The enrollment criteria originally specified that women come to the NMCSD for well baby care beyond the 10-16 day visit and that they should not be pregnant again beyond the index pregnancy. Because these criteria could not be fully assessed until after data collection was underway, some women who were enrolled in the study and contributed data were later deemed ineligible to participate. An analysis was conducted to gauge the comparability of the women enrolled and later determined eligible for the study (study population) to the women who were enrolled and later determined not eligible for the study. Next, because all multivariable analyses require data on certain predictor variables, the study population who contributed all of these essential data elements was compared to the study population who was missing at least one of these elements. Further, we compared the study population with all essential data elements who contributed longitudinal data at the early (0-105 days postpartum), middle (106-258 days postpartum), and late (259+ days postpartum) windows of time compared to the women in the sample with all essential data elements who did not contribute data at all of these timepoints (i.e., who contributed data at only one or two of these timepoints). Finally, present data describing the active duty population in terms of sociodemographic characteristics.

Description of Postpartum Weight

A number of analyses have been conducted to examine the main study outcome of weight change. The various analyses described below used weight, weight retention, or BMI category as the outcome. For all analyses, postpartum weight retention is defined as the prepregnancy weight subtracted from the postpartum weight. A higher postpartum than prepregnancy weight at any given time point could be weight retention or it could represent a woman who lost the weight she gained in pregnancy but then regained weight. The BMI categories are defined in terms of Institute of Medicine non-pregnant guidelines; underweight (BMI <20), normal weight (BMI 20-26), overweight (BMI 26-29), and obese (BMI >29). In certain analyses, these categories are collapsed to reflect low/normal weight (BMI $\leq$25) or overweight/ obese (BMI >25). This latter categorization is consistent with the Screening Recommendations for body composition

revised by the Institute of Medicine's Committee on Body Composition, Nutrition and Health of Military Women in 1998(91).

1. Maternal weight change during reproduction: Exploratory Analyses: The first set of analyses examines the outcomes of weight and BMI at the early, middle, and late timepoints. These analyses were conducted on the entire study population regardless of active duty status or prepregnancy body size. This analysis of the entire population is longitudinal, that is, it includes data only from those women who were followed from early after delivery into the end of the postpartum year. To be included in this Early-Middle-Late cohort (referred to during the remainder of this report as the EML cohort), a woman had to contribute at least one weight measurement during the early, middle and late postpartum windows of time. Both univariate and multivariable analyses were conducted in this cohort. The results of these analyses were recently presented at the meeting of the American Public Health Association (Abrams BF, Prebil LA, Selvin S, Kang M. Prenatal and postpartum maternal body mass changes. Poster presented at the 128th Annual Meeting of APHA. Boston, November, 2000).

Maternal weight change during reproduction: Exploratory Analyses in Active-Duty Women: These analyses utilize data from women at the early, middle, and late timepoints regardless of whether the women contributed data at only one of these timepoints or at more than one timepoint. Only about 20% of the study group was active-duty, and the numbers of active duty women included in the EML cohort are relatively small. Furthermore, comparison of EML active duty women with active duty women who contributed less follow-up data yielded little difference in the study results. To date, only univariate and bivariate analyses have been conducted and no statistical tests are reported because the groups compared at each timepoint are small. We also decided not to test for change over time at this juncture as each timepoint contains data from a slightly different sample.

All of these analyses examined the outcomes by different categories of explanatory variables or confounders measured at the early timepoint, including:

- **Maternal Race:** Where possible, race was determined by women's self report. Where these data were not available, race was obtained from both medical records.
- **Parity:** This variable was determined by medical records abstraction and women's self-report. Parity was used as both a continuous variable and categorized (0 versus 1+)
- **Gestational weight gain:** This was determined using women's self-reported weight gain during pregnancy, and was categorized according to IOM guidelines as low, normal, or high based on a woman's pre-pregnancy BMI.
- **History of Weight cycling:** A repetitive pattern of loss and gain of weight has been suggested as a potential risk factor for retention. Women were asked to report if they had ever lost then regained 10 pounds or more exclusive of pregnancy. Weight cyclers are those who report having lost and regained 10 or more pounds at least three times in their lives.
- **Pre-pregnancy BMI category**: women were classified on self-reported pre-pregnancy BMI according to IOM categories.
- **Marital/partner status**: women were categorized either as married/living with a partner or neither married nor living with a partner. Women were

defined as unmarried/no partner if they reported being unmarried or not living with a partner at any time during the postpartum period.

- **Age:** Women were classified as <20 years, 20-34 years, and 35+ years of age at the time of the index birth.
- **Economic sufficiency**: This is based on the mother's reported confidence that her family could cover their financial obligation. All reported responses to this question were averaged for the postpartum year and women were classified as "always confident", "never confident" or "unsure".
- **Active duty status**: women were classified as active duty based on indication from the various data sources that she was active duty. Otherwise, women were classified as military dependents.
- **Exercise frequency**: reported recreational physical activity less than three times/week or at least three times/week. at the early postpartum visit (approximately 2 months after birth)
- **Infant feeding method**. Breast feeding only, infant formula only, and mixed breast and formula feeding at the early postpartum visit (approximately 2 months after birth)
- **Occupational status**: women were classified as working or not working at the early postpartum visit (approximately 2 months after birth)

2. Differences in Postpartum Weight Loss Between African American and White Mothers

This analysis was conducted as part of a master's thesis (Kang, M. Difference in postpartum weight retention between African American and White mothers. 2000. Master's Thesis conducted at the University of California, Berkeley. Department of Public Health Biology and Epidemiology). We conducted multivariable regression to answer two questions: (1) Is there a difference in postpartum weight retention between African American and White women in this population? (2) If differences exist, what factors might mediate or contribute to these differences? We were particularly interested in the role of Naval duty status in postpartum weight changes. We hypothesized that pressure to meet physical goals might change active duty women's behaviors and pattern of weight change postpartum.

From the full ABC study population, we selected all African American and White women at least 18 years of age delivering live singleton infants weighing at least 2500g. Women who were not of normal pre-pregnancy body mass index (BMI 19.8-26.0) according to the IOM guidelines 13 were excluded because different associations may exist for pregnancy outcomes based on pre-pregnancy size(41). Women who gained more than 70 pounds or who lost weight during pregnancy were also excluded. Because we wanted to understand the pattern of postpartum weight loss, women who became pregnant again during the follow-up period were also excluded. We examined women whose weight was measured or self reported between 10 and 24 months postpartum. We calculated weight retained as the postpartum weight minus the pre-pregnancy weight of the mother in kilograms.

Maternal race was based on women's self-reported race; women who identified as white and no other ethnic or racial group were considered white, while women who self

reported as black or African American were considered African American regardless of additional racial/ethnic groups indicated. Women were considered active duty status if they reported being active duty at any point during the postpartum period, or if there was any indication in prenatal, hospital or naval records of active duty status. This approach erred in the direction of classifying women as active duty that may not have maintained their duty status through the entire postpartum period.

Data on dieting and exercise behaviors between 2 and 6 months postpartum were collected at well-baby clinic visits. Exercise in this study was reported as the number of times in the past 7 days a woman had participated in sports or exercise. For those women with more than one visit during this period, the average of her reported values for exercise was used. A woman was considered to be dieting if she indicated (in a longer checklist of behaviors) that she was eating less, following a low calorie or low fat diet, trying to be more physically active, or reducing junk food in her diet. These behaviors constituted the majority of weight reduction strategies reported. All women who reported dieting between 2 and 6 months postpartum were considered dieters.

Weight cycling and lactation were examined in models, including the number of days a woman reported breastfeeding her infant.

Our main analysis was a linear regression of maternal factors on the amount of pregnancy weight gain that was retained. We initially considered factors shown in the literature to be potentially influential on weight retention. Maternal age, pre-pregnancy weight, parity, pregnancy weight gain, days since birth, mother's height, and infant birth weight were all entered into regression models continuously. Racial group and active duty status were entered as binary variables. Monthly household income and mother's education were considered as markers for socioeconomic status which has been suggested to be important in previous studies longitudinal weight change(44), of postpartum weight(42,45,46), and in several studies of birth outcomes(47). Our study population was, in general, of relatively high education with almost all mothers having completed high school. As a result of this high education level, the education variable included was an indicator for mothers completing at least some college or graduate school.

Linear regressions were conducted on data stratified by race and by active duty status to look for potential interactions. Active duty status showed a different relationship with weight retention in African American mothers than in White mothers, therefore an interaction term for race and active duty status was entered into the full model. Factors were added and removed from the models manually.

Variables were retained in the main linear regression model if they were significantly associated with weight retention, if they changed the relationship between other variables and the outcome or if the removal of the factor negatively impacted the amount of variation explained by the model. For example, a model excluding age and parity explains only 5.6% of the variation in weight retention, whereas an identical model including these two variables explains 6.7% of the variation in retention. The number of days since birth was also retained in all models because we felt that the time window of measurements was too large to treat as one endpoint without controlling for differences in time since birth.

We conducted a second analysis in women who reported exercise and dieting behavior between 2 and 6 months postpartum, and provided information on weight

cycling history. In this sub-analysis, dieting and exercise behaviors were retained, though neither was statistically significant alone. The two variables were included because they were confounders of each other, and because we felt that a discussion the impact of weight cycling necessitated some control for current dieting and energy expenditure. Income was retained in this model because it impacted the parameters for dieting, exercise, and weight cycling. Factors we studied that were not significant predictors of postpartum weight retention in any analyses of our population include mother's education, mother's height, mother's pre-pregnancy weight, infant's birth-weight, and length of breastfeeding.

Three additional analyses were conducted to allow us to compare our findings to those in the literature and to assess the impact of other methodological issues on our results.

Parker and Abrams reported odds ratios for differences in retention between African American and White mothers using national data(43). To allow us to compare our findings to those of this population based sample, logistic regressions were conducted with the variables included in our main linear regression model, using retention of 20 pounds or greater and retention of 10 pounds or greater as the outcome variables.

Many studies have focused on gestational weight gain. The review by Gunderson and Abrams(40), raises serious issues of the statistical interpretation of gestational gain associations. Sufficient evidence has been presented in the literature to establish that there is a correlation between weight gain in pregnancy and weight retention postpartum. The amount of correlation that is a true finding, rather than one induced by the structural relationship between the two variables, is unclear. We chose to focus our analysis and discussion on the differences between African American and White mothers and other less established potential risk factors. We were concerned, however, about potential biases created by removing maternal weight gain from the analyses. We therefore analyzed models including and excluding gestational gain. These models did not differ with regards to our study findings or their significance.

Some women in this analysis did not return to the clinic for a weight measurement between 10 and 24 months, but did mail in follow-up questionnaires with self-reported weight values. Concerned that this might affect our findings, we conducted a sub-analysis excluding self-reported postpartum weight values. The results of that regression were comparable to those in the full model. All analyses were conducted using Statistical Analysis Software(48).

3. Dieting Practices And Postpartum Weight Loss

In this study we address two questions about postpartum dieting and weight retention: 1) What is the prevalence of weight control practices in postpartum women and do they vary by race and other maternal characteristics? 2) Does dieting affect the pattern of postpartum weight retention and does this relationship differ between subgroups of women? This study was conducted and reported as part of a master's thesis (Hoggatt, K. Dieting Practices and Postpartum Weight Loss. 2000. Master's Thesis conducted at the University of California, Berkeley. Department of Public Health Biology and Epidemiology).

Women's responses were grouped into categories by postpartum visit. For the purposes of this analysis, we defined three mean postpartum visit categories to study

prospective weight retention: month 2.5, month 5.5, and month 10.5. Month 2.5 responses consisted of data collected between two and three months postpartum; month 5.5 included months four through seven; and month 10.5 included months eight through thirteen. Only one questionnaire per woman per postpartum visit category was included in the analysis. The data in this analysis included maternal age, pre-pregnancy weight, parity, household income, education, marital/partner status, military active duty status, smoking status, and infant feeding method. In addition, we created variables for maternal race, pre-pregnancy BMI and history of weight cycling.

Data on maternal dieting practices and method of infant feeding were collected from clinic questionnaires. We investigated 24 specific dieting practices using a checklist of behaviors. Women were asked to indicate things they had done to control or lose weight over the past seven days. These behaviors were further grouped into "healthy", "unhealthy", and "did nothing" dieting practice categories. Healthy practices reflected weight control behaviors that met the current clinical recommendation of decreasing caloric intake and increasing physical activity (49). Of the behaviors on our checklist, the ones we considered healthy dieting included "ate less food/followed a low calorie diet", "avoided junk foods", "bought low fat foods", and "tried to be more physically active". Unhealthy behaviors consisted of "skipped meals", "fasted for at least one day", "smoked cigarettes", "took laxatives to lose weight", "took diuretics or water pills", and "intentionally vomited after eating". Two specific behaviors, "I worried but did nothing" and "did nothing", were classified as "did nothing" dieting practices. A dichotomous composite variable for healthy dieting (hereafter referred to as simply "dieting") was created for use in our dieting practices and weight retention analysis. A woman was considered a dieter if she indicated that she used any of the four "healthy" behaviors and did not report using unhealthy behaviors or doing nothing in addition to the healthy behaviors.

Weight retention at each visit (2.5, 5.5, and 10.5 months postpartum) was calculated as the difference between each woman's weight at that visit minus her self-reported pre-pregnancy weight. If a woman completed more than one questionnaire during the time period, we took the average of her reported weights and used this mean value to calculate her weight retention.

Only women who had a normal pre-pregnancy BMI (19.8—26.0 kg/m2) (50) were included in our study population; we excluded 1327 women whose pre-pregnancy BMI was not normal. We also excluded women who had a multiple birth (n=12), gained more than 70 kg during their pregnancy (n=55), became pregnant again during the study period (n=178), provided ambiguous race/ethnicity information (n=86) or had no data from months 2-12 (n=29). Thus, 1253 met our inclusion criteria and were considered our study group. However, many of these women had missing data for either weight or dieting at month 2.5 (n=574 and n=9 respectively) or had already lost their pregnancy weight by month 2.5 (n=73). These women were excluded from our dieting practices group, leaving a total of 597 women. Finally, the multivariate analysis on the pattern of weight loss required a balanced number of observations. Therefore, our weight retention group included only those women who had complete race, diet, and weight information at months 2.5, 5.5, and 10.5 (n=337).

We used a different statistical approach for each of our research questions. To study the prevalence of dieting practices and associated maternal characteristics, we

calculated the proportion of women reporting each of the dieting behaviors included on the checklist. Because women could check as many behaviors as relevant, these proportions did not add to 100%. We used a multiple logistic regression model to analyze the relationship between maternal characteristics and dieting at 2.5 months postpartum. To assess the association between dieting and the pattern of postpartum weight retention in subgroups of women, we used multivariate analysis of variance (MANOVA) with maternal weight retention at the 2.5, 5.5, and 10.5 months postpartum as the multivariate outcome.

The strength of the multivariate analysis of variance model (PROC GLM, MANOVA in SAS 6.12) is that it allows for the analysis of a dependent variable made up of several components. Using this procedure, we built a hierarchical model using a forward/backward elimination process to identify significant predictors of the weight retention pattern at 2.5, 5.5, and 10.5 months postpartum. Independent variables used to construct the model were dieting, maternal age, race, parity, household income, education, military active duty status, history of weight cycling, smoking status, and infant feeding method.

In the first stage of the model building process, we included the main-effects listed above. Main-effects with a p-value <0.10 were retained in the model. Next, interaction terms between dieting and each of the other significant main-effects were added to a main-effects model one at a time and interaction terms with a p-value <0.15 were retained in the subsequent model. Using this criteria, there was evidence of an interaction between race (when we compared Black women to all other women) and dieting. We then stratified the weight retention group into Black and non-Black categories. We used the selection process described above to identify statistically significant main-effects and interaction terms associated with dieting in Black and non-Black women separately. We included these main-effects and interactions in a single model and retained terms that were significant at the 0.10 level using backwards elimination. Main-effects were eliminated only if they were not independently significant at the 0.10 level and were not part of an interaction term that was significant at the 0.10 level. Using the main-effects identified through backwards elimination, we examined interactions between main-effects other than dieting. We retained these interactions in the model if they were significant at the 0.10 level. Thus, our final model included main-effects, interactions between main-effects and dieting, and interactions between main-effects other than dieting that were significant at the 0.10 level using backwards elimination among Black and non-Black women separately.

Due to the observed interaction between dieting, race, and weight retention, we subsequently calculated the prevalence of dieting behaviors separately in Black and non-Black women. T-tests were used to determine which specific dieting behaviors differed between Black and non-Black women.

4. The Relationship of Social Support, Depression and Postpartum Weight Retention.

Another analysis conducted and reported as part of a master's thesis (Wright, Serena. The Relationship of Social Support, Depression and Postpartum Weight Retention. 2001. Master's Thesis conducted at the University of California, Berkeley. Department of Public Health Biology and Epidemiology). The purpose of this research is

to examine the following questions: (a) What impact does social support and depression have on postpartum weight retention? (b) Can social support, independent of socioeconomic factors, reduce postpartum weight retention? (c) Does the role of social support vary for women of different race/ethnic backgrounds? We hypothesized that women with greater amounts of social support will retain less weight and that depressed women will retain more weight in the postpartum.

The main independent variable in this analysis, social support, was measured through self-report on the Clinic Questionnaires. Two types of support, emotional and instrumental,30 from two specific sources (partner and family, friends or paid help), were examined. Mothers were asked the following questions: "Are you getting help at home with taking care of your baby and household chores from your spouse or partner?"; "Are you getting emotional support as a mother of a new baby from your spouse or partner?"; "Are you getting help at home with taking care of your baby and household chores from your family, friends or from paid help?"; "Are you getting emotional support as a mother of a new baby from your family, friends or from paid help?" If she answered yes to any of these questions she was then asked, "If yes, do you feel that you are getting 1) As much support as you need, 2) Some support, but not enough, or 3) Just a little support."

Each woman contributed at least one clinic measure of social support data during the first year postpartum. Due to the hypothesis that the level of social support a person experiences over time is likely to change and that large changes in social support could have greater effects than consistently high or low levels of support, we created summary variables to capture variability in support over the course of the year. For each social support measure, a value was assigned based upon the participants' answer (none=1, high=4). The summary variables from each of the four measures of social support were then added together to capture overall social support during the first year postpartum.

Depression was assessed using the 20-item Center for Epidemiologic Studies Depression (CES-D) Scale. Higher scores indicate greater depressive symptoms, with a score of greater than 15 indicating clinically depressive symptoms that ought to be examined further by a practitioner. For these analyses, depression was examined categorically, to describe differences between mothers who were and were not depressed early in the postpartum period, as well as continuously in the multivariate models.

We used information on rank as a measure of socioeconomic status. For the purposes of this analysis, if the mother was active duty then the rank variable reflects her rank. If the mother was not in the military then the rank variable reflects the father's rank. Average monthly household income was collected categorically and translated to a continuous variable based upon the minimum value of the category. Education was coded according to the mother's highest level of attainment. Race was coded according to self-report. If a mother reported being only White and no other racial or ethnic group then she was coded as White. Women who reported being Black were coded as Black regardless of other racial or ethnic groups indicated. Women who reported a mixed race of White and Asian were coded as Asian, as were women who reported being Guamanian, Filipina, or Pacific Islander. Those who reported a mixed race/ethnicity of White and Hispanic were coded as Hispanic.

The analytic sample for this study is limited to women who contributed data on weight at three months or later postpartum, had data on prepregnancy weight, and did not become pregnant again during the study period. 1667 met our inclusion criteria; women

were further excluded from the study if they were missing data on gestational weight gain (n=187), rank (n=4), income (n=218), education (n=4), parity (n=26), age (n=3), baseline depression (n=135), social support (n=6), or provided ambiguous race data (n=46). This left a total of 1039 women in the analytic sample.

Two outcome variables, weight retention and postpartum weight, were examined in this analysis. Weight retention is the difference between the mother's postpartum weight measure and her self-reported prepregnacy weight. In models examining postpartum weight as the outcome, weight retention was calculated from the model. Weight was examined at approximately 9 months postpartum. The primary predictor variable was social support. The main covariates examined were depression, race, socioeconomic status, prepregnancy weight, height, and pregnancy gain.

Using ANOVA models, we examined differences in mean weight retention adjusted for the time of the mother's postpartum weight measurement. Additionally, we examined the univariate distributions of mean weight retention based on demographic and psychosocial characteristics. To understand social support in this group of women, we began with a cross-sectional examination of the levels of social support at each well-baby visit. While the levels of social support provided from all sources declined slightly over time, these changes were minimal. A number of variations in the analysis were attempted, including using the earliest measure of social support only, dichotomizing support as high/medium versus low/none, and dichotomizing support as any versus none. The results of these analyses were highly divergent. The average measure of each social support variable over the first postpartum year is presented here, as this gave the least variable result.

Multivariable linear regression was used to examine the relationship between social support and postpartum weight. We built a model in a stepwise fashion, assessing the affects of rank, income, education, and race, and controlling for the relationship of prepregnancy weight, pregnancy gain, and maternal height to postpartum weight. Based upon the observation that socioeconomic factors play a significant role in health problems and the fact that we were attempting to see what effect social support can have holding SES as constant as possible, all socioeconomic variables were kept in the model. Biological variables such as parity and maternal age were added to the model. Psychosocial factors were added to the model to examine the effects of depression and social support independent of other factors. Based upon a priori hypotheses that income and social support could have interactive effects with themselves, squared terms for each of these variables were added to the model.

To account for hypothesized interactions of the effects of social support and depression on postpartum weight retention, we conducted stratified analyses to assess sub-population differences in predictors of postpartum maternal weight. While race/ethnicity was not an independent predictor of postpartum weight, stratified analyses revealed interactions and the results presented here describe the divergent patterns of postpartum weight that we discovered. We lacked sufficient power to further examine interactions between social support and depression and other variables within women of different racial groups.

5. Weight Cycling and Postpartum Weight Retention

This study specifically examined the relationship of weight cycling to pregnancy weight gain and postpartum weight retention. To simplify interpretation, the analysis was conducted in white women only (n=549). Women who reported a history of dieting and regaining 10 or more pounds at least twice were classified as weight cyclers. We used separate multiple linear regression models (adjusting for prepregnancy weight, height and sociodemographics) to study how weight cycling related to gestational weight gain and to postpartum weight retention (mean time =311 days after birth). Since there was evidence that prepregnancy BMI modified these relationships, we stratified the data into two groups (BMI <26 or >26) for the final models.

Results of analyses conducted

Description of the study population

Figure 1 shows the flow of data from initial recruitment through final data available for analysis. The NMCSD's computerized Composite Health Care System (CHCS) database shows that there were 7,723 infants who received at least one Well-Baby visit at the NMCSD during the period of this study and this group served as our sampling frame. Of these, we had available study staff to approach and introduce to the study to 4391 (57%). Of these, 655 (15%) refused to be screened, and 3736 (85%) agreed to be screened for the study.

One thousand one hundred thirty nine women were screened ineligible for the study. This included mothers of adopted infants; mothers who did not speak English; infants who had spent >96 hours in the Intensive Care Nursery and mothers who did not plan to seek future well-baby care at Balboa Pediatrics Clinic. It also includes 360 mothers who either intially enrolled their newborn infants in the study but never returned to NMCSD for additional well-baby care after the newborn visit or who became pregnant again after enrolling in the study. A comparison of these women who enrolled in the study but were later determined ineligible versus women enrolled and eligible (study population) is presented in Table 1. The study population is statistically significantly different from the ineligible enrolled women on a number of socioeconomic variables, including race (higher proportion white), active duty status (lower proportion active duty), and marital status (higher proportion married) ($p<.05$).

There was substantial loss to follow-up of enrolled women in this study, which is not unexpected, considering this highly mobile military population. In fact, data collection was designed to allow women to contribute only a single measurement, though we had hoped that the cross-sectional data could be combined into a large prospective cohort. Therefore, the usual assumptions about the viability of a longitudinal cohort are not completely applicable here.

Because this study was originally designed to collect all data from mothers in the well-baby clinic setting (rather than relying on the more expensive options of requiring women to attend a special study clinic or collecting data on home visits by study staff), we did not have the resources to track all study participants who failed to provide data and therefore we cannot account for the exact reason why women were "lost to follow-up". However, we were able to learn informally that in addition to direct deployment of mothers and military transfers of the families, the following conditions contributed to loss

to follow-up: mothers changed their source of pediatric care from Balboa to another clinic; mothers did not bring their infants in for all scheduled well-baby visits; working mothers did not appear in the clinic because they sent their infants for well-baby care with fathers or other adults; mothers left the area to be with their families at home of record when fathers were deployed. Attempts to contact mothers by mail and telephone indicated that this was a highly mobile and difficult-to-trace population, even when mothers continued to reside in San Diego.

Similarly, a number of statistically significant differences are noted between the study population with all essential data and those missing at least one element of essential data (Table 2); women who contributed all data are slightly older, more educated, have a higher income, and a higher proportion are white, are military dependants, and are married ($p<0.05$). Finally, women in the sample with all essential data who contributed data at the early, middle, and late timepoints (EML cohort) (n=861) are only statistically significantly different from women who contributed data at only one or two of these timepoints on parity ($p<0.001$); women in the EML cohort are of lower parity than women not in this cohort (Table 3). These differences should be kept in mind in the interpretation of all analyses, as results may not be generalizable to the population of all women receiving care at the NMCSD. However, it is interesting to note that Tables 2 and 3 suggest that, based on available data, the women represented in the analytical sample appeared similar to those not represented with regards to prepregnancy weight, pregnancy weight gain and BMI before and after pregnancy. For example, Table 2 shows that there were no significant differences between the study group with complete data and the group with missing data in the proportion of overweight women during the early, middle and late postpartum year. Table 3 shows that although there were significantly more women with overweight postpartum BMI during the postpartum "middle" period (with 48% of the EML cohort overweight compared to about 40% of those not included in the EML cohort), there were no significant differences in BMI category during the early period or at the end of follow-up late in the postpartum year. These comparisons suggest that although women with complete data differ in certain sociodemographic characteristics from those without complete data, the pattern of weight change from before pregnancy through the first year does not appear to be substantially different between these groups.

Table 4 presents the sociodemographic characteristics of the active duty women in the sample (n=579). Given the emphasis on physical readiness for active duty women, we were surprised that approximately 23% of these women were overweight or obese prior to pregnancy. However, this finding is consistent with that of Bray and colleagues who estimated in 1995 that 22.9% of Naval active duty women aged 26-34 were overweight (BMI > 25.7), though the prevalence was less than 20% in younger women. (cited in Committee on Body Composition, Nutrition and Health of Military Women, Institute of Medicine, Assessing Readiness in Military Women, National Academy Press, Washington DC, 1998.)

Description of Postpartum Weight

1. **Maternal weight change during reproduction: Exploratory Analyses:**

- EML cohort

- Includes all prepregnancy BMIs
- Active duty and dependent women

Longitudinal analysis of BMI in the EML cohort

Figure 2 show that the study population, on average did not return to its prepregnancy BMI values by the end of follow-up. The distribution of pre-pregnancy and postpartum BMI by maternal characteristics is presented in Figures 3 to 8. As shown in Figure 3, there is heterogeneity in BMI by race prior to pregnancy, and this heterogeneity is maintained over the postpartum year. While 25-30% of white, Black, and Hispanic women were overweight or obese prior to pregnancy, less than 15% of Asian women were overweight or obese prior to pregnancy. During the postpartum year, the proportion of overweight or obese white women decreased from approximately 50% at the early period to nearly 45% at the late period, but never returned to pre-pregnancy levels of less than 30%. Similarly in Black women, nearly 55% were overweight or obese at the early period, never decreasing below 50% during the postpartum year; this represents a near doubling in the prevalence of overweight or obesity among these women from pre-pregnancy to postpartum. Among Hispanic women, the prevalence of overweight or obesity never fell below 50% in the postpartum year. The lowest levels of overweight/obesity were observed among Asian women, who still showed a large increase in prevalence from pre-pregnancy to postpartum.

The postpartum increase in overweight/obesity is clearly demonstrated in Figure 4. Were there no increase in the prevalence of overweight/obesity, none of the women who were underweight or normal weight pre-pregnancy would be obese/overweight postpartum; by the late period, approximately 5% of previously underweight women and approximately 30% of previously normal weight women were overweight or obese. Among previously overweight women, nearly 40% were obese by the late period.

In Figure 5, pre-pregnancy and postpartum BMI is presented by the amount of gestational weight gain (based on Institute of Medicine recommendations, standardized by prepregnancy BMI category). While there appears to be little difference in the prevalence of postpartum overweight/obesity between the groups that gained less than recommended or the recommended amount, women who gained more than the recommended amount had nearly double the rates of postpartum overweight/obesity compared to the other two weight gain groups. This finding may be due to higher levels of overweight/obesity pre-pregnancy.

Women who report always feeling confident about their economic sufficiency to have a lower prevalence of overweight/obesity both pre-pregnancy and postpartum; the prevalence is higher among women who report never being confident or being uncertain. (Figure 6). At pre-pregnancy and postpartum, active duty women have a lower prevalence of overweight/obesity than military dependents (Figure 7)--this topic will be addressed in greater detail in the next section. Figure 8 shows that women who have a history of weight cycling have more than double the prevalence of overweight/obesity at pre-pregnancy than women without such a history and this difference is maintained throughout the postpartum year.

Multivariate analyses: To examine the unique contributions of these and other independent variables on postpartum BMI, a multivariable linear regression model was run at the early, middle, and late periods (Table 5). This analysis includes women of all

prepregnancy BMI classifications. Each beta coefficient in this table represents the change in postpartum BMI associated with a one-unit increase in the independent variable. For example, a one-unit increase in pregnancy weight gain was associated with a 0.18 increase in early postpartum BMI, and this difference is statistically significant as the confidence interval does not cross 0 (95% CI 0.16, 0.20). At no timepoint was active duty status statistically significantly associated with postpartum BMI controlling for the other factors in the model, though the beta coefficient was consistently negative, suggesting slightly lower BMIs among active duty women compared to military dependents. The amount of pregnancy weight gain was the only variables that was consistently statistically significantly associated with an increase in postpartum BMI controlling for the effects of the other variables in the model. A number of other variables were statistically significantly associated with an increase in postpartum BMI at one or two of the timepoints. For example, having a history of weight cycling was statistically significantly associated with a 0.55 to 0.63 unit increase in BMI at the middle and early postpartum timepoints; a similar association was found at the late period (0.53), but this association was not statistically significant. There were no independent variables that were consistently statistically significantly associated with a decrease in BMI. At the early and middle periods, the statistically significant predictors of BMI were pregnancy gain (b=0.18 early, b=0.14 middle) and a history of weight cycling (b=0.63 early, 0.55 middle). Despite the relatively few number of statistically significant findings, these model explains 82% of the variance in early postpartum BMI and 68% of the variance in postpartum BMI at the middle period. At the late period, the variables statistically significantly associated with BMI included Black race (compared to White race, b=0.75), never having the ability to pay bills (compared to always being able to pay bills, b=0.92), dieting at the early postpartum time period (b=-0.65), and the amount of pregnancy gain (b=0.10). This model explains 61% of the variance in late postpartum BMI.

Cross-sectional analysis of BMI in the active duty women Mean early postpartum weight retention in 362 active duty women was 6.6 kg (sd = 6.7). Mean middle postpartum weight retention for 373 women was 5.6 kg (sd=8.0) and the 366 active duty women with data in the late postpartum year retained an average of 4.1 kg (sd=7.2). We examined the amount of weight retention at the late period among active duty women by independent variables measured at the early period. These associations are univariate, so may be highly confounded, but serve as an initial exploration of the effects of these variables on weight retention in the active duty population. Weight retention varied by lactation status; women who were exclusively breast feeding at the early period had the lowest weight retention at the late period, followed by women who were both formula and breast feeding, and women who were exclusively formula feeding (2.8, 4.9, and 5.3, respectively). We plan to explore the role of lactation in both active duty and military dependents in the coming year. Little difference was observed in late weight retention between women who reported exercising 0-2 times versus those who reported exercising 3 or more times at the early period, and between women who dieted at the early period versus women who did not.

Figures 9-15 illustrate the proportion of active-duty women with overweight or obese BMI values before pregnancy and throughout the postpartum year based on cross-sectional analyses. These results are similar to those described for the entire cohort,

though the overall proportion of overweight at each time frame is lower, probably reflecting the physical readiness requirements of active-duty women.

Conclusions

These exploratory analyses have aided in the identification of a number of factors associated with postpartum weight retention, both in the entire study population and among active duty women. There is a high prevalence of postpartum overweight/obesity compared to pre-pregnancy levels, and the factors associated with this outcome vary by postpartum timepoint. Further exploration of these factors in a multivariable context among active-duty women, including the role of PT, will provide further insight into the prevention of overweight/obesity among this subset of the study population.

2. Differences in Postpartum Weight Loss Between African American and White Mothers

- Women with late weight measure
- Includes only women with normal prepregnancy BMI
- Includes only African American and white women
- Active duty and dependent women

The primary analysis consisted of 458 women, 84 African American mothers and 374 White mothers. A comparison of the eligible study population to those women analyzed and those excluded is shown in Table 6. A description of the main sample for this study by race and by active duty status can be found in Table 7. Of particular interest is the number of women in each study category that became overweight or obese as a result of pregnancy. The proportion becoming overweight or obese was highest among African American non-active duty women (50%) and lowest among White non-active duty women (16%).

The main linear regression showed a strong effect of active duty status on weight retention in African American mothers, but not in White mothers. Results of this analysis are in Table 8. After adjustment for marital status, parity, age, and time since birth, being active duty was associated with a 0.52 kg increase in weight retention for White mothers. African American race was associated with a 4.62 kg increase in weight retention for non-active duty mothers and a 1.05 kg increase in weight retention for active duty mothers with respect to White non-active duty mothers. Only the increase observed in African American non-active duty women was statistically significant at the $p=0.05$ level.

The results of the sub-analysis including postpartum exercise, dieting and history of weight cycling are shown in Table 9. The increased risk of retention in African American non-active duty mothers is 4.16 kg for this model. Interestingly, the addition of the new factors to the model changes the coefficient for African American active duty to – 1.28, suggesting that after controlling for behavioral factors, the African American active duty women are actually at less risk of retention than White active duty women compared to White non-active duty mothers. Having a history of weight cycling was a risk factor for retention in this model.

When we adjusted for partner status, mother's age, parity, duty status, and time since birth, our logistic regression analyses gave an odds ratio of 2.29 (95% CI 1.38, 3.79) for a 10 pound retention and an odds ratio of 2.26 (95% CI 1.25, 4.09) for a 20 pound retention among African American mothers compared to White mothers (data not presented). These odds ratios are derived from models that do not include the interaction of race and active duty status. When these terms are included the only the odds ratios for African American non-active duty are significant compared to White non-active duty mothers for retention of 10 pounds or more the odds ratio for non-active duty African Americans is 4.27 (95% CI 2.07, 8.83). For weight retention of 20 pounds or more, the odds ratio for this group is 3.70 (95% CI 1.71, 8.04).

Conclusions

The results of our analysis show that the differences commonly reported in the literature in weight retention between African American mothers and White mothers are

not explained by education nor by income, the two most commonly used markers for socioeconomic status(47). Another common hypothesis that is presented to explain the differences in health between groups is access to care. All women in this study had equal access to care through their own, or their partners' military medical coverage. Thus the differences we observed are not explained by differences in access to medical care. The results of this study also suggest that genetic difference between races, another proposed explanation for health differences between African American and White mothers(47,52) do not the explain the differences we observe in postpartum weight retention. If the difference were genetic, we would not expect the association to change by duty status. Our findings among the active duty servicewomen suggest that active duty status may serve as a marker for other influential and unstudied differences.

The risk of weight retention in African American mothers in our study was similar to that found in national data. When we compared our logistic regression analysis to that of Parker and Abrams(43), we found similar results. In models that did not adjust for the interaction between race and active duty status, we find an increased risk among African American women for retention of both 10 and 20 pounds postpartum compared to White women. Logistic models including the race by active duty interaction also showed an increased risk of weight retention for non-active duty African American mothers with respect to White active and non-active duty women, but showed no increased risk of weight retention among active duty African American mothers with respect to White mothers.

Of particular clinical interest is the number of women in our study that became classified as having a BMI considered overweight or obese as a result of pregnancy weight gains. Half of the African American non-active duty women had moved into a higher weight category at 10-24 months postpartum.

Although previous research, including two studies that assessed the effects of race have suggested that large maternal pre-pregnancy size is an important risk factor for postpartum weight retention(43, 53-55), these factors were not significant in our results. We suspect that a relationship may exist, but in our population, we did not find evidence for such a relationship.

An association between pregnancy weight gain and post-pregnancy weight retention has been found consistently across other studies(41, 56-62).

Of those studies looking at lactation behaviors, some found a weak relationship between lactation and weight loss or body fat(63-65), though others have found no significant relationship(66). The evidence looking across studies is inconclusive. There seems to be a modification of the relationship of lactation with weight and body fat patterns that depends both on the duration of breastfeeding and the intensity of feeding. There may be other factors involved in the relationship between lactation and weight change. Dewey et al. found that in a randomized trial of lactating mothers, those who were enrolled in a regular exercise program improved cardiovascular fitness but did not lose body fat or weight(66). Thus it may be possible that lactation has an effect on the way that energy intake and expenditure is mediated during the postpartum period. We found no significant relationship between breastfeeding and postpartum weight. We considered only duration rather than a duration and intensity score, which may have decreased our ability to detect a difference, but our finding is consistent with existing scientific literature.

This unique military population allowed us to assess the impact of several important factors not previously studied. Although Alexander et al. found some evidence of a narrower gap in birthweight and infant mortality outcomes between African Americans and Whites in military service(67), to our knowledge, this is the first study to examine the difference in postpartum weight loss between African Americans and Whites in a military population. We also had access to information on exercise, weight cycling and dieting behaviors collected before the weight outcome was measured.

We have little indication of what factors might account for a lack of racial difference in this outcome among active duty servicewomen. Women who enter the U.S. Navy must be free of a range of previous medical conditions, and must meet physical readiness standards to enter service. To maintain active duty status they must also maintain these physical standards. Active duty women may be more motivated to regain pre-pregnancy fitness than non-active duty women. This finding is confusing given the lack of difference between active duty and non-active duty women among White mothers. We were unable to find any factors that explained the differential impact of active duty status on African American mothers compared to White mothers.

Neither the dieting nor the exercise variables used in this study appeared to explain the differences in weight retention, and were not significantly different between active duty and non-active duty women in the two racial groups. This would seem to indicate that the difference found between active duty and non-active duty women is not due to self-reported dieting or exercise. Shauberger et al. found return to work to be protective against weight retention(68). It may be that part of the impact of active duty status on weight is mediated by the return to work. This possible relationship is one that should be considered in future studies of postpartum weight change.

3. Dieting Practices And Postpartum Weight Loss

- EML cohort
- Includes only normal prepregnancy BMIs and women with weight left to lose at each time frame
- Active duty and dependent women

Table 10 shows the demographic characteristics of women in the study group for this analysis (n=1253), the dieting practices group (n=597), and the weight retention group (n=337). The average age of women in our study group was 26 years and their average weight before pregnancy was 59.4 kg (131 lb.). The average weight retention of women who had not regained their pre-pregnancy weight by the second month postpartum was 7.4 kg (16 lb.) at month 2.5, 6.4 kg (14 lb.) at months 5.5, and 4.6 kg (10 lb.) at months 10.5. Most women had attended college (57.5%), were Caucasian (53.3%), and lived with their spouses or partners (91.9%). About one-third of women were in active duty service. None of these characteristics differed significantly between the study group and the dieting practices or weight retention groups. However, income was significantly higher in the weight retention group than in the study group. In addition, women in the dieting practices group were less likely to have a history of

weight cycling and those in the weight retention group were more likely to be current smokers than were women in the study group.

Table 11 shows the prevalence of specific weight control behaviors reported at about 2.5 months after delivery. At least one in five women we studied reported eating less food or following a low-calorie diet, trying to be more physically active, avoiding junk foods, and using low-fat foods. Nearly one quarter of women in the study reported they did nothing to control their weight, although some of these women also reported using a weight control behavior. The prevalence of healthy weight control behaviors among all women in our dieting practices group was 48.2%. Of the women who indicated they were doing something to control their weight, 64.6% reported using healthy dieting practices, such as reducing their energy intake or increasing their physical activity. The most commonly reported unhealthy weight control behaviors were skipping meals (19.4%) and cigarette smoking (5.3%). Few women reported other unhealthy behaviors such as fasting, vomiting, or using laxatives and diuretics. Very few of the women in the dieting practices group received help to lose weight. Less than 1% reported receiving nutrition counseling from a dietitian, nutritionist, or other health care provider, or participating in an organized weight control program.

Table 12 shows the factors associated with dieting at month 2.5. Crude analyses suggested that Black and Filipino women were less likely to use healthy weight control practices at month 2.5 compared to White women. However, after adjustment for other factors, the multiple logistic model showed that only Black women were less likely to report dieting compared to White women (OR=0.29; 95% CI, 0.08-1.00). In addition, women who were current smokers at baseline were less likely to diet at month 2.5 compared to former or non-smokers, even with the other variables held constant (OR=0.17; 95% CI, 0.05-0.56).

We used a MANOVA model to examine the pattern of weight retention. An advantage to the MANOVA model was that it permitted analysis of each woman's series of highly-correlated postpartum weights. It also had the statistical power to detect the difference in patterns of weight retention between groups even though the difference in average weight retention between groups at any given time point was not significant. Although MANOVA allows us to study correlated outcomes, a disadvantage to using this model is that it can only be implemented by on a balanced set of observations. Therefore, our weight retention analysis for a given variable included at most 337 women.

Using MANOVA, we found that the pattern of weight retention differed by race. White, Asian, Filipino, and Hispanic women had similar patterns of weight loss between 2.5 and 10.5 months postpartum, while Black women had a significantly different pattern (p-value=0.004) (Figure 16), and there was evidence of an interaction between race and dieting (p-value=0.13). Due to this observed interaction, we examined the pattern of weight retention by dieting status in Black and non-Black women separately (Figure 17). Among Black women, dieters weighed 2.4 kg more than non-dieters at 2.5 months postpartum, and this difference persisted at 5.5 months (2.5 kg) and 10.5 months (2.5 kg). In contrast, non-Black women who reported dieting at 2.5 months had the same average weight retention as women who did not report dieting, while at 5.5 months dieters weighed 1.3 kg less than non-dieters, and at 10.5 months dieters weighed 1.2 kg less than non-dieters.

When we stratified women into two race groups (Black and non-Black) and ran the MANOVA models separately in these two groups, (tabled data not shown) we found that the pattern of weight retention in non-Black women was predicted only by dieting (p-value=0.001), while the pattern in Black women was predicted only by income (p-value=0.06). In non-Black women, as stated previously, dieting was associated with a pattern of lower weight retention between 2.5 and 10.5 months postpartum. In Black women, we found that higher income was associated with lower weight retention at months 5.5 (p-value=0.03) and 10.5 (p-value=0.01), but not month 2.5 (p-value=0.21).

Table 13 shows the prevalence of specific dieting behaviors among Black and non-Black women separately. There were significant differences between Black and non-Black women with respect to several dieting behaviors. Non-Black women were more likely than Black women to eat less or follow a low-calorie diet, to avoid junk foods, to use low fat foods, and to drink diet soft drinks. Conversely, Black women were more likely than were women of other races to report doing nothing to control their weight. The overall proportion of women reporting healthy dieting was significant greater in non-Black women (49.9%) compared to Black women (37.5%; p=0.04).

Conclusions

Nearly half of the women we studied reported using healthy dieting practices at 2.5 months postpartum to lose their pregnancy weight gain. Both the prevalence of dieting and the pattern of weight retention differed between Black and non-Black women. Dieting at 2.5 months postpartum was associated with a pattern of lower weight retention in non-Black women, while among Black women only income predicted the pattern of weight retention.

The proportion of women in our study who reported dieting was lower than has been reported in the general population. In our dieting practices group, 64.6% of women who indicated they were using some weight control technique reported using healthy behaviors, such as eating fewer calories or less fat and increasing their physical activity. Serdula, et al. conducted a population-based study of weight control practices in 107,804 adults and showed that 92.2% of women who reported they were trying to lose weight did so by eating fewer calories or less fat and 65.7% used physical activity (49). Other studies have shown that 70-80% of adult women try to control their weight by reducing the food or calories they consume and 60-80% control their weight through physical activity (69,70). Although the reported prevalence of these behaviors may depend on how the questions on dieting behaviors are phrased (71), making comparisons across studies difficult, it is also possible that postpartum women are actually less likely than non-postpartum women to control their weight through diet and exercise.

There are several possible reasons why postpartum women may not choose to diet or exercise to lose the weight gained in pregnancy. First, women may be concerned that efforts to lose weight through energy restriction will impair their lactation (72). However, our results would seem to contradict this hypothesis since women in our study who exclusively breastfed at month 2.5 were as likely to report dieting as were women who exclusively bottlefed. Second, some researchers have suggested that parous women may be less concerned with controlling their weight compared to nulliparous women (73). This explanation is speculative since most studies of dieting and exercise in the

general population have not reported prevalence by parity category (49, 69, 70, 71, 74). A final explanation is that postpartum women simply do not have the time or energy to focus on a diet and exercise regimen in the first few months following their delivery. We are not aware of any studies that have looked at maternal attitudes toward dieting as a method for weight loss in the postpartum period, which suggests further research in this area is needed.

We examined specific dieting behaviors reported at 2.5 months postpartum and found that healthy behaviors were far more prevalent than unhealthy ones. Other studies that have looked at specific dieting behaviors in women have reported similar findings (69, 70, 74, 75). Our results also show that the prevalence of extreme unhealthy behaviors (i.e., fasting, vomiting, and taking diuretics or laxatives) was low in our population. This was consistent with studies by Neumark-Sztainer, et al. (75) and Levy and Heaton (74), however French, et al. reported a higher prevalence of unhealthy dieting behaviors (69). Thus, while overall dieting may be lower in postpartum women than in women from the general population, the specific practices reported by both groups are similar, and they tend to be healthy behaviors.

Reported dieting differed across subgroups of the women we studied. When the model was adjusted for the influence of other variables, women who were current smokers were less likely to report dieting than were former or non-smokers, and Black women were less likely to report dieting than were women of other races. These results are consistent with other studies (49). However, in contrast to other studies (70, 76), we did not find associations between dieting at 2.5 months postpartum and income or education in our multiple logistic model.

Dieting at 2.5 months postpartum was associated with a pattern of lower weight retention in most of the women we studied. However, the MANOVA analysis showed evidence of an interaction between dieting and race (defined as Black and non-Black). As Figure 17 suggests, Black women who dieted weighed more on average at 2.5 months postpartum, and this difference persisted at 5.5 and 10.5 months postpartum. In contrast, non-Black women retained less weight at 5.5 and 10.5 months postpartum than their non-dieting counterparts, despite having the same average weight retention at 2.5 months postpartum. Thus, not only were Black women less likely to report dieting in the postpartum period, they also did not seem to benefit from it.

There are several possible explanations for this difference between Black and non-Black women. First, reported dieting may or may not reflect meaningful changes to eating and exercise patterns. Neumark-Sztainer, et al. reported that the association between reported dieting and actual energy intake might depend on how dieting questions are worded (77). Their study also suggests that reported dieting may represent different behaviors in subgroups of women. Our results tend to confirm this hypothesis. We found that Black women were about as likely to use physical activity as were non-Black women, but they were 25-60% less likely to control their energy intake by eating less, following a low-fat or low-calorie diet, or avoiding junk foods. Thus, Black women who were considered dieters in our analysis used different specific dieting behaviors to lose their pregnancy weight. If the methods Black women used were less effective than those chosen by non-Black women, it could explain why dieting did not seem to help Black women lose weight.

Another explanation for the findings in Black and non-Black women is that the duration of weight loss efforts might differ between the two groups. There is some evidence that the duration of weight loss efforts is more important than the type of behavior used (69). Some research has shown that Black women tend to use weight control behaviors for shorter periods of time than do women of other races (78), possibly because Black women are less concerned with their weight than other women are (71). This suggests that Black women in our study may have dieted less rigorously or for a shorter time than non-Black women did, which could explain the greater weight retention we observed at 5.5 and 10.5 months.

A third explanation for the difference between Black and non-Black women in our study is that they could differ with respect to another variable that is associated with both dieting and weight loss. If this were the case, we would expect to see an association between this factor and weight retention in both Black and non-Black women, yet none of the variables we studied predicted weight retention in both groups of women. However, it is also possible that factors we did not measure, associated with both dieting and weight loss, explain the differences between Black and non-Black women. Although confounding by such a factor cannot be ruled out, most of the variables that have been shown to be associated with both dieting and weight retention in postpartum women were included on the ABC questionnaires.

An important finding from this study is that women did not report receiving help to lose their pregnancy weight. Overall, less than 1% of the women in the dieting practices group indicated they had received nutritional counseling or participated in an organized weight loss program. This is particularly striking given our finding that women in this study retained more weight in the first postpartum year than other studies have reported (79, 80). Weight retention is a source of concern for new mothers, and some experts have suggested that the best approach to helping women lose their pregnancy weight is individual nutritional assessment and counseling (81-83). Women in this study may not have received this type of support due to financial constraints or other factors. For instance, many counseling or weight loss programs are expensive and perhaps unaffordable for women in this study, among whom the average monthly household income was less than $2300. Yet these women did not report using the military-sponsored weight loss program either. This suggests that there may be barriers other than cost that prevent women from seeking help in losing weight. Health care providers devote considerable resources to ensure women receive nutritional counseling during pregnancy. Our study suggests that a greater effort needs to be made to provide women with nutrition and weight loss counseling after the baby has been born.

Almost half of the postpartum women we studied reported they dieted to lose their pregnancy weight. They tended to use healthy behaviors such as reducing energy intake and exercising. Reported dieting differed by race and baseline smoking status. Among non-Black women, dieting seemed to reduce the amount of weight retained over the first 2.5-10.5 months postpartum, while among Black women, only household income was shown to be associated with weight change between 2.5 and 10.5 months postpartum. Our results suggest that a regimen of healthy diet and exercise helps many women lose the weight gained during pregnancy, however the effectiveness of the regimen may differ across subgroups of women. Randomized controlled trials are needed to determine the optimal combination of energy restriction and exercise that will

permit women to lose their pregnancy weight. Postpartum women may not be receiving the information and support they need to lose their pregnancy weight gain. A greater effort is needed to ensure access to nutritional counseling and weight loss assistance in the first year postpartum.

4. The Relationship of Social Support, Depression and Postpartum Weight Retention

- Women with a postpartum weight > 3 months after delivery
- Includes all prepregnancy BMIs
- Includes active duty and dependents

Table 14 describes compares the demographic characteristics of all women in the study group (n=1667), and the women who were included in the final analytic sample (n=1039). The average prepregnancy weight for the analytic sample was 64.3 kg (141.5 lb) and the mean weight retention was 5.2 kg (11.4 lb). The proportion of women who were overweight (BMI>25) rose from 29% before pregnancy to 46% postpartum. Women reported moderate amounts of social support and 32% of women met the CES-D cut-off for depression. The average age was 26 years old and the average monthly income was $2104. Most women were primiparous (50%), White (60%), college educated (49%), and married (94%).

Social support (Figure 18) was a weak and inconsistent predictor of postpartum weight retention in univariate analyses. While medium levels of instrumental support from family and friends and no emotional support from family and friends were statistically significant predictors of postpartum weight retention ($p<0.05$), there was no dose response effect. Even though weight retention increased as emotional support from family and friends decreased, only the effect of no support was statistically significant ($p<0.05$). Further, these results were highly variable depending on which social support measure was used and how it was coded.

Univariate analysis assessed the impact of individual socioeconomic and psychosocial variables on postpartum weight retention (Table 15). All results are adjusted for the time of the postpartum measure. There were significant effects of prepregnancy BMI, maternal age, income, education, cesarean delivery and depression at 2 months postpartum on postpartum weight retention. Further, parity and rank approached significance as univariate predictors of postpartum weight retention ($p<0.1$). Race, marital status, active duty military status, and depression at Follow-up were not significant predictors of postpartum weight retention at 9 months postpartum.

Differences in demographic variables for women of different race/ethnic groups are described in Table 16. Mean depression scores showed little difference across groups, however the prevalence of depression among Hispanic women was higher than the prevalence in the other groups (37% v 30.4-32.4%). Hispanic women also had the highest mean score for social support (2.02), followed by Blacks (1.95), Whites (1.88), and Asians (1.78). Asian women showed lower prepregnancy and postpartum weight, weight retention, higher age, higher income, higher levels of education, and lower prevalence of overweight at prepregnancy and postpartum. Black women had higher

mean weights, retained more weight, had a higher prevalence of overweight prepregnancy and postpartum, were less likely to be married and were more likely to be multiparous. Hispanic women reported the lowest mean income, lower mean age, lower education, lower rank, and were more likely to be active duty. White women were most likely to be military officers or wives of officers, least likely to be active duty, and most likely to be married.

Predictors of postpartum weight from the multivariate models are summarized in Table 17. For the analytic sample, social support, social support squared, and depression were statistically significant predictors of postpartum weight ($p<0.01$). Furthermore, prepregnancy weight, maternal weight at delivery, and parity were also statistically significant. Height, rank, income, education, marital status, and race were not significant predictors.

The analyses of postpartum weight, stratified by race, are also presented in Table 17. In both White (n=619) and Black (n=139) women the only significant predictors of postpartum weight were prepregnancy weight and maternal weight at delivery. Among Hispanics (n=167), in addition to these variables, marital status approached significance ($p<0.1$). Significant predictors of postpartum weight among Asian women (n=114) were prepregnancy weight, height, parity, marital status, and social support squared ($p<0.05$). Further, rank, income and income squared all approached significance ($p<0.1$).

As in the unstratified model, social support squared is significantly associated with postpartum weight in Asian women ($p<0.05$), however this relationship was not statistically significant for the other racial/ethnic groups. Among Black women, the coefficients for depression (0.098 v 0.050), social support (5.52 v 2.37), and social support squared (-1.24 v –0.65) were of a greater magnitude than in the unstratified model, although they did not achieve statistical significance. This same effect was observed among both Hispanic and Asian women for depression (both 0.08 v 0.05). Conversely, the magnitude of the coefficients for White women were lower for depression (0.03 v 0.05), social support (2.1 v 2.4), and social support squared (-0.48 v –0.68). The results of the unstratified analyses are presented alongside the race stratified models to emphasize the difference in coefficients and assess the impact of sample size on the results.

Figure 19 describes the adjusted postpartum weight of a normal weight for height woman (BMI=23.1) based upon the linear equation for each of four multivariate models stratified by race/ethnicity. This description clearly illustrates a dose response in weight retention consistent across all four race/ethnic groups varying by the level of social support and depression each woman experienced. Regardless of race, women who were both depressed and reported low social support experienced higher levels of weight retention than women who were not depressed and had high social support. The dose response effect in Whites was the least dramatic, with an adjusted weight retention of nearly 4.5 kg in women with low social support and depression and 3.1 kg in women with high social support and no depression. A similar but higher magnitude relationship was observed in Black women, with low social support and depression predicting the greatest weight retention (7.9 v 4.4 kg). In all four categories, Black women retained more weight than women of any other race/ethnic group. The slope of the dose response pattern was steepest in Asian (difference of 6.2 kg between highest and lowest groups) and Hispanic women (difference of 5.5 kg). Further, among Asian women with no

depression and high social support, the model predicts a weight loss of 0.7 kg in the postpartum period.

Conclusions

These findings support that hypothesis that social support and depression impact weight retention in postpartum women. Social support, with the effects of depression held constant, independently predicted postpartum weight. Additionally, depression appeared to modify the relationship between social support and weight retention in a dose response pattern; depressed women with low social support retained the most weight and not depressed women with high social support retained the least. This data illustrated significantly different unadjusted and adjusted mean weight retention among women who were depressed in the early postpartum period and those who were not.

These data suggest that depression and social support act in concert and that although the timing of the risk is unclear they are important factors. Results of these analyses indicate noteworthy differences in predictors of postpartum weight retention among women of different racial/ethnic groups. The dose-response pattern of the effect of social support and depression on postpartum weight retention was consistent in all multivariate models. Although social support was only statistically significant in the sub-analysis of Asian women, the dose-response pattern in all sub-analyses was consistent with the statistically significant unstratified model.

In addition to Black/White differences, these data allowed a unique opportunity to examine the predictors of postpartum weight retention in Asian and Hispanic women. The dose response of social support and depression showed the greatest slope in Asian women, suggesting that social support, or lack of it, had a much stronger effect in this group. This magnitude of effect was similar, though not quite a steep, in Hispanic women. Unfortunately, there is a paucity of literature on postpartum weight among Asian and Hispanic women. Studies of social support suggest that social networks have different effects and meanings for women than men(84), as well as for people of different cultural backgrounds(85-90). These stratified analyses, showing rather different effects of marital status and social support, lend credence to that viewpoint. Further, these results point to a need for better understanding of social support and depression among postpartum women of non-White racial/ethnic groups.

5. Weight Cycling and Postpartum Weight Retention

Because a history of weight cycling has appeared as an important predictor in virtually all of the analyses conducted so far, we have begun an in-depth exploration of this variable and its association with postpartum weight. So far, preliminary analysis of the effect of weight cycling on postpartum weight retention showed that cyclers had significantly higher pregravid BMIs, and postpartum weight retention (postpartum weight-prepregravid weight, 5.1 kg., sd=8.1 vs 3.6 kg., sd=5.8) but overall similar gestational gain during pregnancy (16.0 kg., standard deviation (sd)=6.0 vs 15.8 kg., sd=5.3) compared to non-cyclers.

In multivariable regression models, history of weight cycling was associated with increased gestational gain and postpartum retention in the non-overweight group. After adjustment for covariates and gestational age, cyclers who were not overweight gained more weight during pregnancy ($b=1.61$ kg, $p<0.01$). After adjusting for covariates,

gestational gain and time since delivery, non-overweight cyclers retained more weight late in the postpartum year (b=1.43, p=0.03) than non-cyclers. In contrast, weight cycling was not significantly associated with either gestational gain or postpartum weight retention in women who were overweight before pregnancy.

Issues, Problems and Solutions

In the 1999 Annual Report, we raised a number of issues related to the methods by which we were attempting to improve upon the quality of entered data and to finalize the data set. Finalization of the data set is now nearly complete. Because of the problems encountered in the originally-entered data, data analysis has not progressed as quickly as anticipated, but can now proceed as planned. The following issues have evolved from this current report:

- In the coming months, we would like to work with DoD personnel to obtain more detailed data on active duty status for the study group to determine any changes in status during the postpartum year not captured in our data collection efforts. We feel this is particulary important to assess, given that about 25% of women who were active duty at delivery became overweight or obese. For example, it would be useful to determine whether the proportion fo women who remained on active duty status by the end of the postpartum year compared to those who separated. This, in turn, suggests that these women could not meet physical readiness standards by a year after delivery. We We are also interested in exploring possible predictors of the relatively high prevalence of pre-pregnancy overweight in the active duty women.

- Using the most cursory data on physical activity, we have found no effect so far on postpartum weight retention. In the coming year, we will use more in-depth measures to assess whether exercise is associated with increased weight loss or reduced risk of postpartum overweight. We also intend to analyze data on PRT in the active-duty mothers.

- We intend to assess the reliability and validity of the self-reported prepregnancy weight estimate provided by the mothers because this measure is the basis of one of our major outcome variabless, postpartum weight retention or postpartum change in BMI. Preliminary analysis suggests that the self-reported weight which was recalled for this study during the postpartum period correlates well with the self-reported weight that recalled and recorded in the medical records during the first trimester of pregnancy (r=0.94). This is reassuring, and we plan to examine this relationship in greater detail during the coming year.

- We intend to conduct descriptive and multivariate analyses directed at the role of the following variables on maternal postpartum weight:
  - breastfeeding throughout the year after delivery
  - the pattern of maternal weight gain during gestation
  - body image, particularly by maternal race
- By the end of the funding period, we intend to examine the women who begin pregnancy with a low or normal BMI and become overweight or obese (BMI > 25) byt the late postpartum year so that we can attempt to identify the risk factors for developing obesity in new mothers.

- For the final analyses, we plan to use analytic techniques to interpolate missing data for confounders. This step will maximize the sample size available for multivariable analysis.
- We are currently investigating statistical methods that will allow us to best exploit the longitudinal nature of these data.

Key Research Accomplishments

- We have completed recruitment, data collection and data entry for the study group of new mothers attending the well-baby clinic at the Naval Medical Center, San Diego. We enrolled more than 2500 eligible women and obtained essential data from 1652 of them. Data on the major endpoint, maternal weight late in the postpartum year, are available for more than 1600 of these women, and longitudinal data, reflecting weight measures during the early, middle and late periods of the postpartum year, are available for 861 women. Approximately 20% of the study participants are active duty women.
- Women in this study, on average, retained more weight late in the postpartum year than usually reported (about 4 kg in this study compared to means of 1.5 to 2 kg in previous studies). We do not know whether this is due to specific characteristics of this population, or simply reflects the "obesity epidemic" currently seen in all age groups in the United States.
- An sub-analysis limited to white and African American women who began pregnancy within normal BMI standards indicated that 50% percent of African American military dependent mothers became overweight or obese by the end of the postpartum year. However, there was no difference in prevalence between white and black Active duty mothers or white dependent mothers; approximately 25% of each of these groups had become overweight or obese late in the postpartum year.
- Multivariate analyses suggest that:
  - African American women are more likely to retain weight after delivery compared to white women, but this difference is not observed within Active Duty women. The explanation for the lowered risk of obesity in active duty African American women does not appear to be increased exercise, increased dieting, higher income or higher education.
  - Women who pursue "healthy dieting" behavior early in the postpartum year retain less weight later than those who do not diet. However, this

finding may not hold for African American women. It appears that many women do not diet or seek assistance with weight loss after delivery.
    - We found no evidence that exercising 3 times a week is associated with a greater weight loss than exercising less.
    - Women under financial stress are more like to begin pregnancy overweight and more likely to become overweight in the year after birth.
- Postpartum depression and low levels of social support appear to be independent risk factors for postpartum weight retention.
- Women with a history of weight cycling are at risk for postpartum weight retention.

The vast amount of data that still remain to be analyzed during the remaining 18 months of this study should contribute important information on additional risk factors for weight retention or protective factors for postpartum weight loss.

Reportable Outcomes

Manuscripts, abstracts, presentations:

Katherine Hoggatt, Dieting Practices and Postpartum Weight Loss, 2000, Master's Thesis conducted at the University of California, Berkeley, Department of Public Health Biology and Epidemiology

Mi-Suk Kang, Difference in postpartum weight retention between African American and White mothers, 2000, Master's Thesis conducted at the University of California, Berkeley, Department of Public Health Biology and Epidemiology

Serena Wright, The Relationship of Social Support, Depression and Postpartum Weight Retention, 2001, Master's Thesis conducted at the University of California, Berkeley, Department of Public Health Biology and Epidemiology

Mi Suk Kang , Barbara Abrams, and Steve Selvin, Black-white differences in postaprtum weight loss, presented June 2000 at The Thirteenth Annual meeting of the Society for Pediatric and Preinatal Epideiologic Research in Seattle, WA

Barbara Abrams, Lee Ann Prebil, Steve Selvin, and Mi Suk Kang, Prenatal and postpartum maternal body mass changes, presented November 15, 2000 at The 128th Annual meeting of APHA in Boston, MA

Barbara Abrams, Weight after Pregnancy: Is Motherhood Fattening? Results of the ABC study, presented November 2000 at the Nutritional Sciences seminar at the University of California, Berkeley

Degrees obtained:

Mi Suk Kang, MPH
Katherine Hoggatt, MPH

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Smoking, Weight and the Childbearing Year, Barbara Abrams PI, applied for January 2001 through the Tobacco Related Disease Research Program

Conclusion of this Annual Report

The results we report here suggest the following:

- Women in this study, on average, retained more weight late in the postpartum year than usually reported (about 4 kg compared to 1.5 to 2 kg). We do not know whether this is due to specific characteristics of this population, or simply reflects the "obesity epidemic" currently seen in all age groups in the United States.
- Multivariate analyses suggest that:
  - African American women are more likely to retain weight after delivery compared to white women, but this difference is not observed within Active Duty women. The explanation for the lowered risk of obesity in active duty African American women does not appear to be increased exercise, increased dieting, higher income or higher education.
  - Women who pursue "healthy dieting" behavior early in the postpartum year retain less weight later than those who do not diet. However, this finding may not hold for African American women. It appears that many women do not diet or seek assistance with weight loss after delivery.
  - We found no evidence that exercising 3 times a week is associated with a greater weight loss than exercising less.
  - Women under financial stress are more like to begin pregnancy overweight and more likely to become overweight in the year after birth.
  - Postpartum depression and low levels of social support appear to be independent risk factors for postpartum weight retention.
  - Women with a history of weight cycling are at risk for postpartum weight retention.

Implications:

At the present, we can state with confidence that postpartum weight retention appears to be a serious issue among both the Active Duty and dependent women included in this study. Although in some racial groups, Active Duty women appear to retain somewhat less weight than dependents, we found that 1 in 4 Active Duty women who began pregnancy within weight standards (BMI <25) ended the postpartum year above this standard. Thus, identification of factors that increase weight retention or protect against it is needed, and we are confident that continued analysis of the study data will contribute to this end.

We anticipate that when finalized, the results of the ABC study will be useful in the development of data-based standards which reflect the experiences of women who will return to acceptable levels of weight and fitness on their own, and thus could reduce the number of women who require formal rehabilitation, and the possible stresses that it may impose. So far, our results do not indicate that increased levels of exercise are helping women to lose weight, though encouraging "healthy dieting" early in the postpartum year may modestly increase weight loss for most women. Current results

suggest certain subgroups who deserve further study and possibly, specialized clinical attention during the prenatal and postpartum periods. This includes: African American military dependent women, those with a history of weight cycling, those with depression after birth and those experiencing financial instability or insufficiency.

In the coming year, we will examine in more detail the issue of excessive weight gain during pregnancy as well as physical activity.

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Figure 1. Description of Enrollment and Follow Up

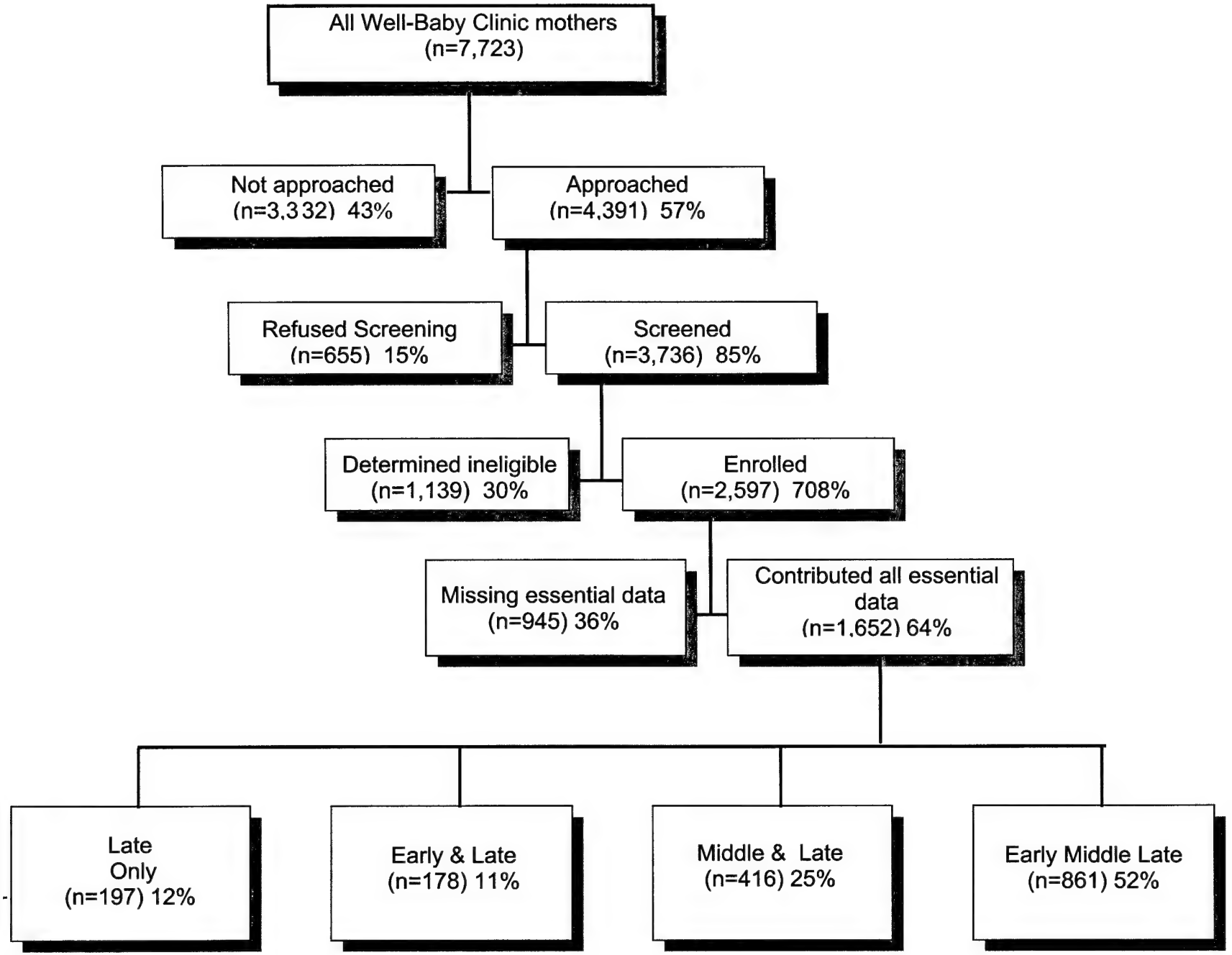


Figure 2. BMI Change Over Time (n=766)

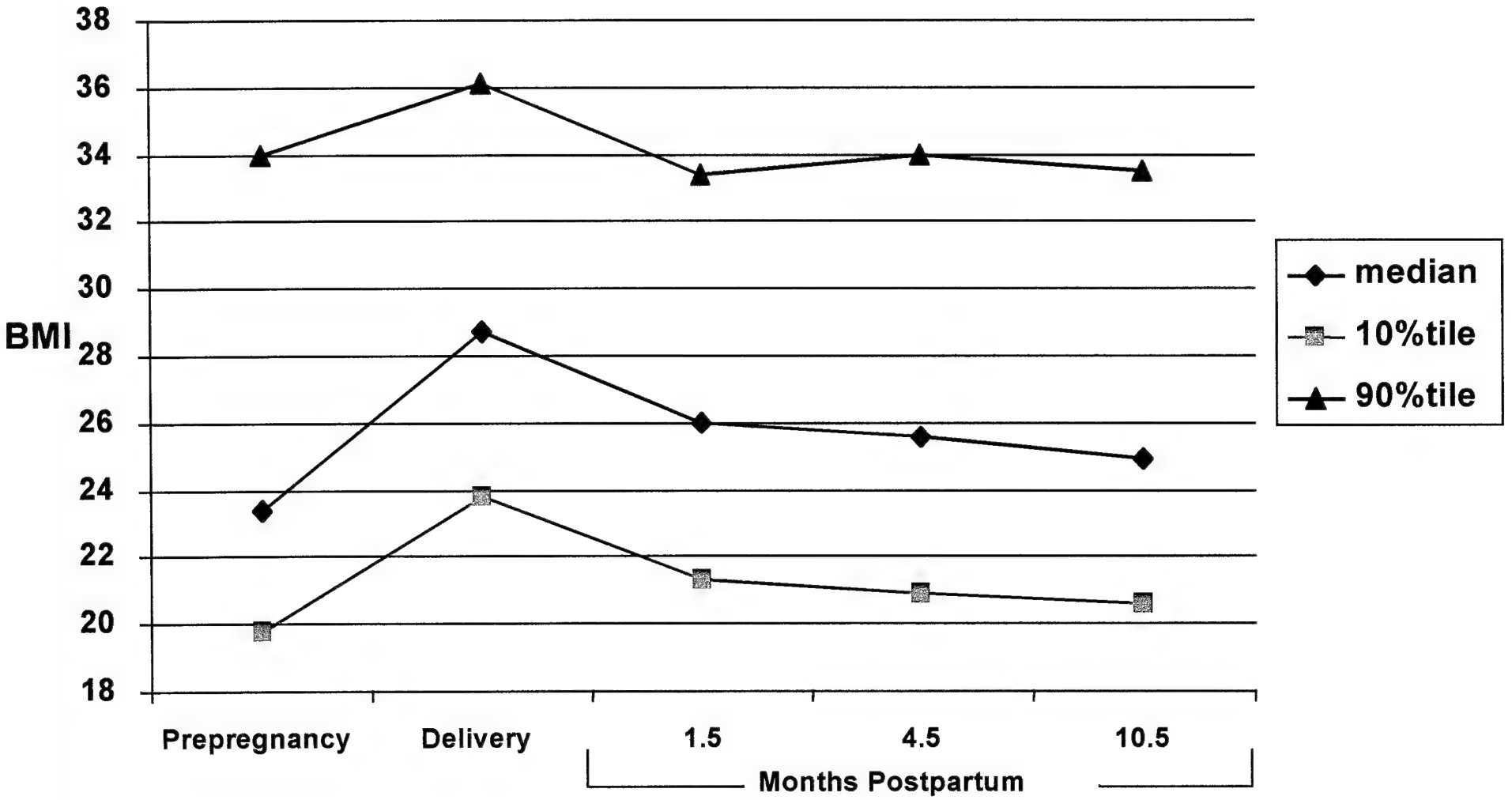


Table 1. Comparison of characteristics of study participants who were enrolled and later determined ineligible to participants who were enrolled and eligible*.

Characteristic	Eligibility Status: Enrolled but Ineligible n=360	Enrolled & Eligible n=2,597	Test Statistic	p-value
Age (mean, sd)	n=339 25.2 ± 5.2	n=2581 25.7 ± 5.4	t =1.81	0.07
Pre-pregnancy weight (kg) (mean, sd)	n=225 64.6 ± 13.7	n=2331 64.6 ± 14.1	t=0.0048	0.99
Pregnancy Weight Gain (kg) (mean, sd)	n=225 16.4 ± 6.5	n=2174 16.3 ± 7.8	t=.18	0.86
Mother's race (n, %)	n=308	n= 2467		
White	148 (48.1)	1339 (54.3)		
Black	46 (14.9)	379 (15.4)		
Asian	17 (5.5)	110 (4.5)		
Filipino	35 (11.4)	190 (7.7)	χ^2=18.3	0.006
Hispanic	53 (17.2)	384 (15.6)		
Native American	0 (0.0)	36 (1.5)		
Other	9 (2.9)	29 (1.2)		
Active duty status (n, %)				
Military Dependant	255 (70.8)	2018 (77.7)		
Active Duty	105 (29.2)	579 (22.3)	χ^2=8.4	0.004
Education (n, %)	n=154	n=2130		
Some college	89 (57.8)	1170 (54.9)	χ^2=0.48	0.49
Less than college	65 (42.2)	960 (45.1)		
Married/Living with partner (n, %)	n=307	n=2567		
Yes	195 (63.5)	2352 (91.6)	χ^2=214.8	< .001
No	112 (36.5)	215 (8.4)		
Income (dollars) (mean, sd)	n=155 2440 ± 1387	n=2096 2540 ± 1400	t=0.86	0.39
Parity (mean, sd)	n=299 0.8 ± 1.0	n=2394 0.8 ± 0.9	t=0.8	0.43

***Eligibility includes meeting entry criteria at screening, returning to the clinic after the 10-16 day visit, not becoming pregnant twice during the study period, and contributing at least one clinic questionnaire**

Table 2. Comparison of characteristics of study participants who contributed all basic, essential data and those who were missing essential data*.

Characteristic	Eligibility Status: Missing Essential Data n=945	Contributed all Essential Data n=1652	Test Statistic	p-value
Age (mean, sd)	n=929 25.0 ± 5.2	n=1652 26.2 ± 5.5	t =5.4	< 0.001
Pre-pregnancy weight (kg) (mean, sd)	n=679 64.3 ± 13.6	n=1652 64.8 ± 14.3	t=0.80	0.43
Pregnancy Weight Gain (kg) (mean, sd)	n=645 16.4 ± 8.1	n=1529 16.3 ± 7.7	t=.31	0.76
Pre-pregnancy BMI category	n=748	n=1652		
Underweight/Normal	538 (71.9)	1180 (71.4)	χ^2=0.1	0.80
Overweight/Obese	210 (28.1)	472 (28.6)		
Postpartum weights:				
Early BMI category	n=551	n=1038		
Underweight/Normal	255 (46.3)	509 (49.0)	χ^2=1.1	0.30
Overweight/Obese	296 (53.7)	529 (51.0)		
Middle BMI category	n=590	n=1241		
Underweight/Normal	314 (53.2)	679 (54.7)	χ^2=0.36	0.55
Overweight/Obese	276 (46.8)	562 (45.3)		
Late BMI category	n=262	n=1619		
Underweight/Normal	161 (61.5)	922 (57.0)	χ^2=1.9	0.17
Overweight/Obese	101 (38.6)	697 (43.0)		
Mother's race (n, %)	n=815	n= 1652		
White	405 (49.7)	934 (56.5)		
Black	150 (18.4)	229 (13.9)		
Asian	34 (4.2)	76 (4.6)	χ^2=14.1	0.03
Filipino	68 (8.3)	122 (7.4)		
Hispanic	136 (16.7)	248 (15.0)		
Native American	13 (1.6)	23 (1.4)		
Other	9 (1.1)	20 (1.2)		
Active duty status (n, %)	n=945	n= 1652		
Military Dependant	702 (74.3)	1316 (79.7)	χ^2=10.0	0.002
Active Duty	243 (25.7)	336 (20.3)		
Education (n, %)	n=592	n=1538		
Some college	292 (49.3)	878 (57.1)	χ^2=10.4	0.001
Less than college	300 (50.7)	660 (42.9)		
Married/Living with partner (n, %)	n=915	n=1652		
Yes	821 (89.7)	1531 (92.7)	χ^2=6.7	0.01
No	94 (10.3)	121 (7.3)		
Income (dollars) (mean, sd)	n=582 2337 ± 1264	n=1514 2618 ± 1441	t=4.1	< 0.001
Parity (mean, sd)	n=742 0.8 ± 1.0	n=1652 0.8 ± 0.9	t=1.1	0.29

***Essential data defined as race, maternal age, parity, active duty status, pre-pregnancy weight, maternal height, marital status, delivery weight, and contribution of weight data in the late postpartum period (9+months)**

Table 3. Comparison of characteristics of study participants in the Early-Middle-Late cohort versus those not in the Early-Middle-Late Cohort *.

Characteristic	Eligibility Status: Not in EML Cohort n=791	In EML Cohort n=861	Test Statistic	p-value
Age (mean, sd)	n=791 26.0 ± 5.7	n=861 26.3 ± 5.3	t =1.0	0.32
Pre-pregnancy weight (kg) (mean, sd)	n=791 64.6 ± 14.8	n=861 65.0 ± 13.8	t=0.52	0.60
Pregnancy Weight Gain (kg) (mean, sd)	n=689 16.4 ± 8.0	n=840 16.3 ± 7.4	t=.24	0.81
Pre-pregnancy BMI category	n=791	n=861		
Underweight/Normal	570 (72.1)	610 (70.9)	χ^2=0.3	0.59
Overweight/Obese	221 (27.9)	251 (29.2)		
Early BMI category	n=178	n=860		
Underweight/Normal	81 (45.5)	428 (49.8)	χ^2=1.1	0.30
Overweight/Obese	97 (54.5)	432 (50.2)		
Middle BMI category	n=414	n=827		
Underweight/Normal	250 (60.4)	429 (51.9)	χ^2=8.1	0.01
Overweight/Obese	164 (39.6)	398 (48.1)		
Late BMI category	n=777	n=842		
Underweight/Normal	451 (58.0)	471 (55.9)	χ^2=0.7	0.39
Overweight/Obese	326 (42.0)	371 (44.1)		
Mother's race (n, %)	n=791	n= 861		
White	445 (56.3)	489 (56.8)		
Black	107 (13.5)	122 (14.2)		
Asian	38 (4.8)	38 (4.4)		
Filipino	59 (7.5)	63 (7.3)	χ^2=1.1	0.98
Hispanic	123 (15.6)	125 (14.5)		
Native American	11 (1.4)	12 (1.4)		
Other	8 (1.0)	12 (1.4)		
Active duty status (n, %)	n=791	n= 861		
Military Dependant	644 (81.4)	672 (78.1)	χ^2=2.9	0.09
Active Duty	147 (18.6)	189 (21.9)		
Education (n, %)	n=714	n=824		
Some college	394 (55.2)	484 (58.7)	χ^2=2.0	0.16
Less than college	320 (44.8)	340 (41.3)		
Married/Living with partner (n, %)	n=791	n=861		
Yes	723 (91.4)	808 (93.8)	χ^2=3.6	0.06
No	68 (8.6)	53 (6.2)		
Income (dollars) (mean, sd)	n=705 2543 ± 1395	n=809 2683 ± 1478	t=1.9	0.06
Parity (mean, sd)	n=791 0.9 ± 1.0	n=861 0.7 ± 0.8	t=4.0	<0.001

***Among participants who contributed all essential data. Early Period=0 to 105 days postpartum; Middle Period=106 to 258 days postpartum; Late Period=259+ days postpartum.**

Table 4. Sociodemographic characteristics of active duty women

Characteristic	n=579	
Age	n=572	
(mean, sd)	24.7 ± 5.1	
Pre-pregnancy Weight (kg)	n=507	
(mean, sd)	64.2 ± 10.5	
Pregnancy Weight Gain (kg)	n=453	
(mean, sd)	17.2 ± 6.9	
Pre-pregnancy BMI category	n=579	
Underweight/Normal weight	385	(66.5)
Overweight/Obese	132	(22.8)
Missing	62	(10.7)
Early BMI category	n=579	
Underweight/Normal weight	167	(28.8)
Overweight/Obese	213	(36.8)
Missing	199	(34.4)
Middle BMI category	n=579	
Underweight/Normal weight	201	(34.7)
Overweight/Obese	194	(33.5)
Missing	184	(31.8)
Late BMI category	n=579	
Underweight/Normal weight	233	(40.2)
Overweight/Obese	147	(25.4)
Missing	199	(34.4)
Race (n, %)	n=579	
White	261	(45.1)
Black	159	(27.5)
Asian	15	(2.6)
Filipino	12	(2.1)
Hispanic	81	(14.0)
Native American	12	(2.1)
Other	8	(1.4)
Missing	31	(5.4)
Education (n, %)	n=579	
Some college	196	(33.9)
Less than college	229	(39.6)
Missing	154	(26.6)
Married/Living with partner (n, %)	n=579	
Yes	473	(81.7)
No	98	(16.9)
Missing	8	(1.4)
Income (dollars)	n=421	
(mean, sd)	2786 ± 1531	
Parity	n=541	
(mean, sd)	0.44 ± 0.66	

Figure 3. BMI by Race

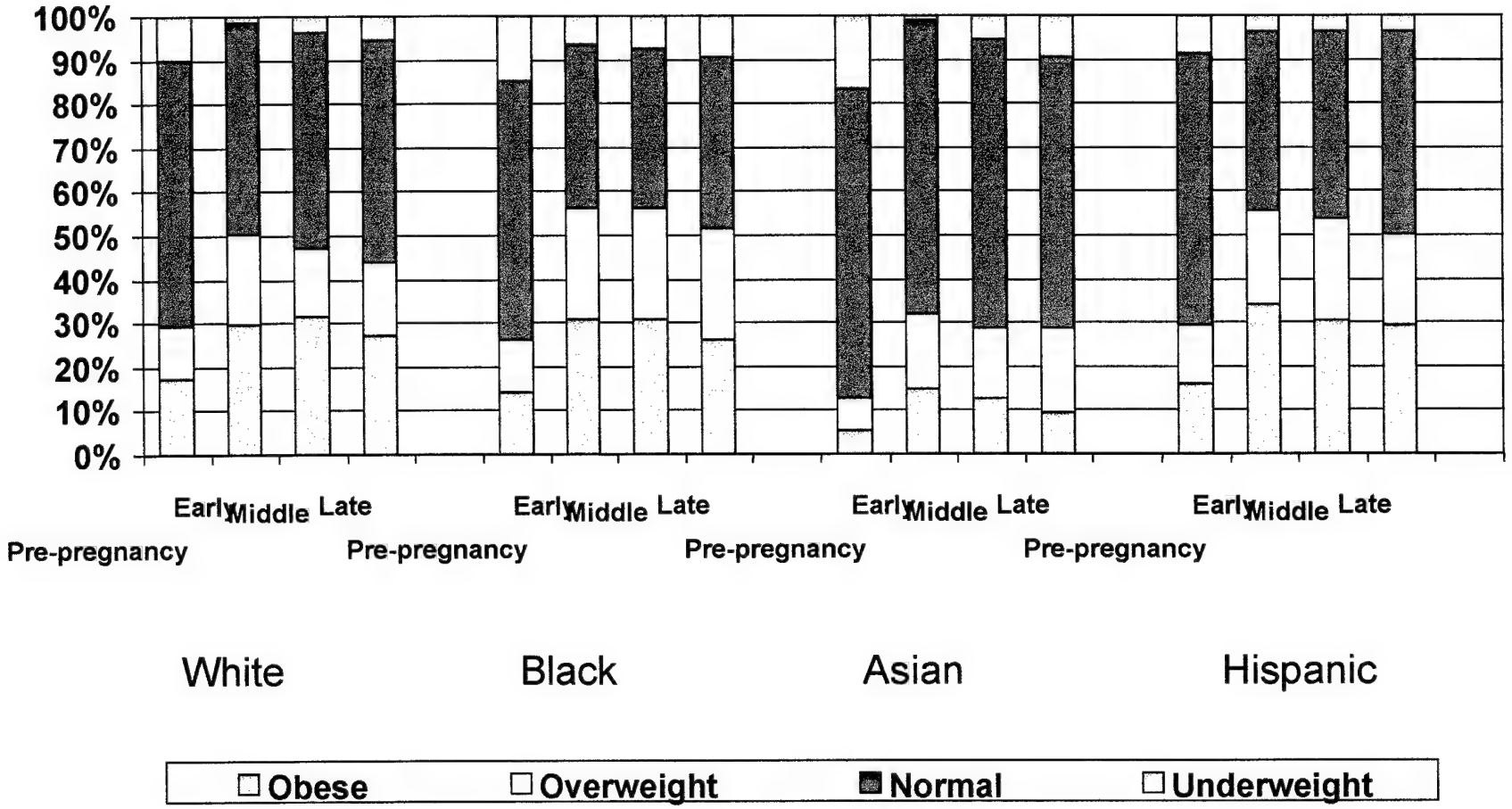


Figure 4. BMI by Prepregnancy BMI

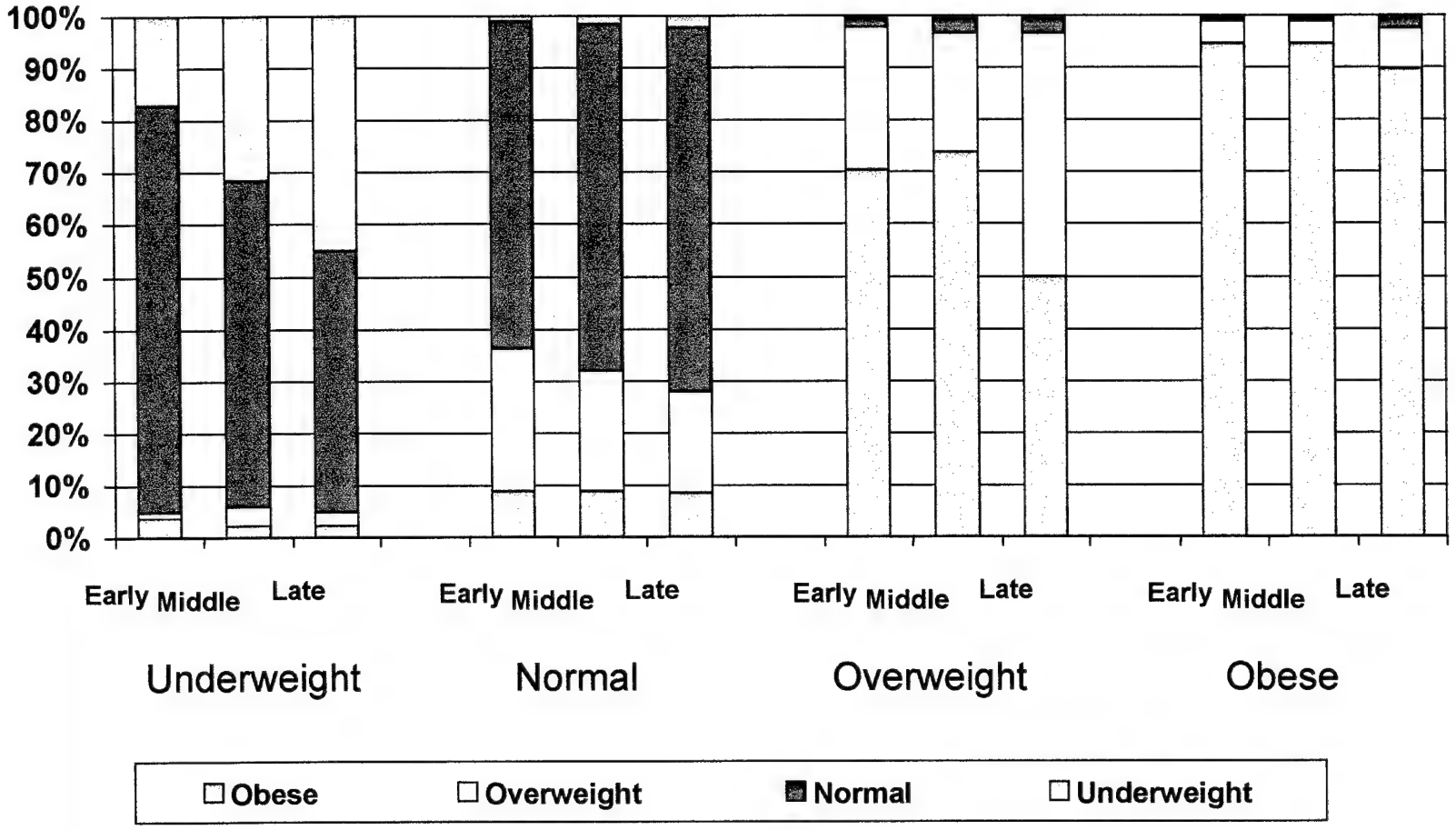


Figure 5. BMI by Gestational Weight Gain

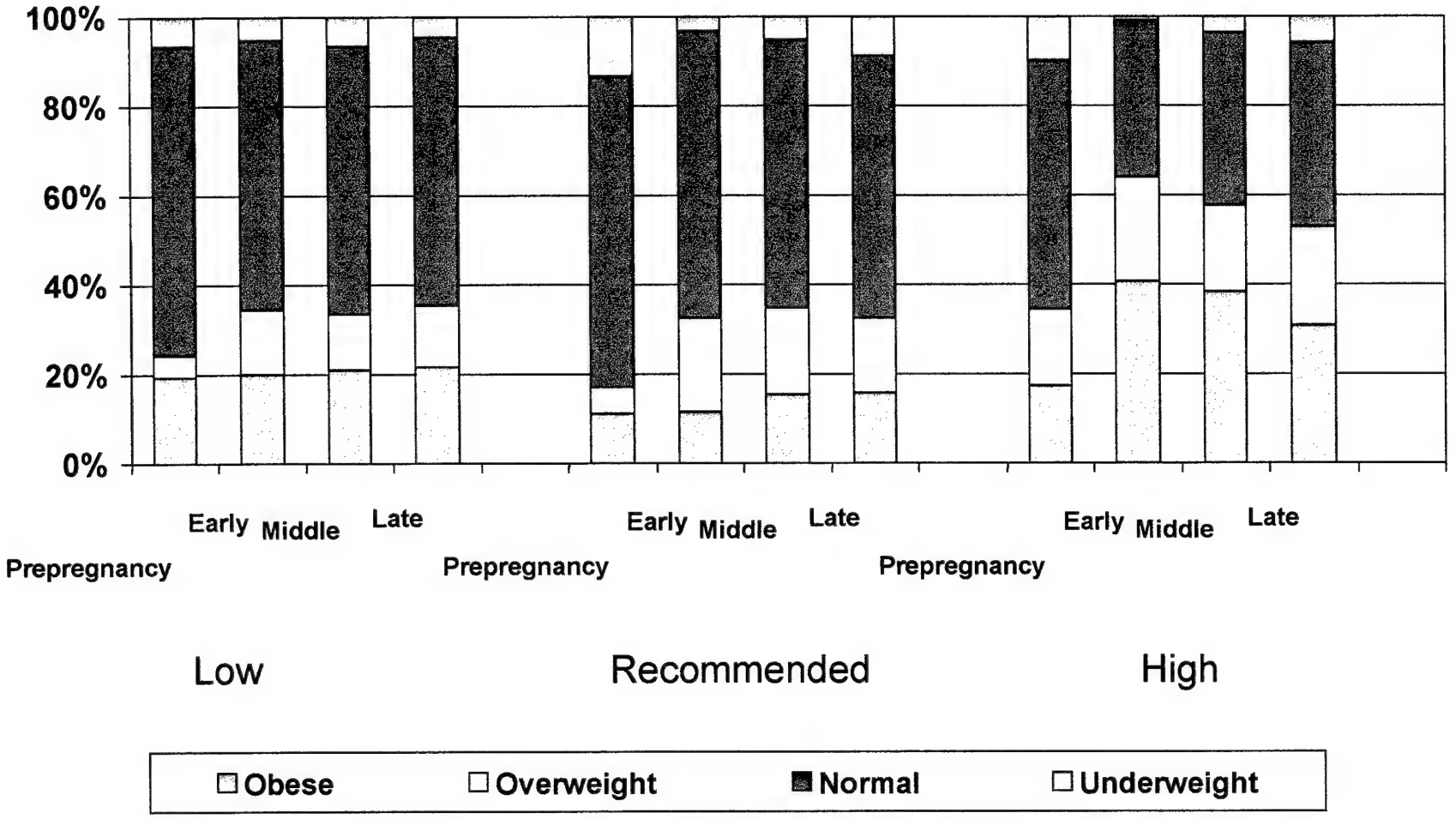


Figure 6. BMI by Confidence about Economic Sufficiency

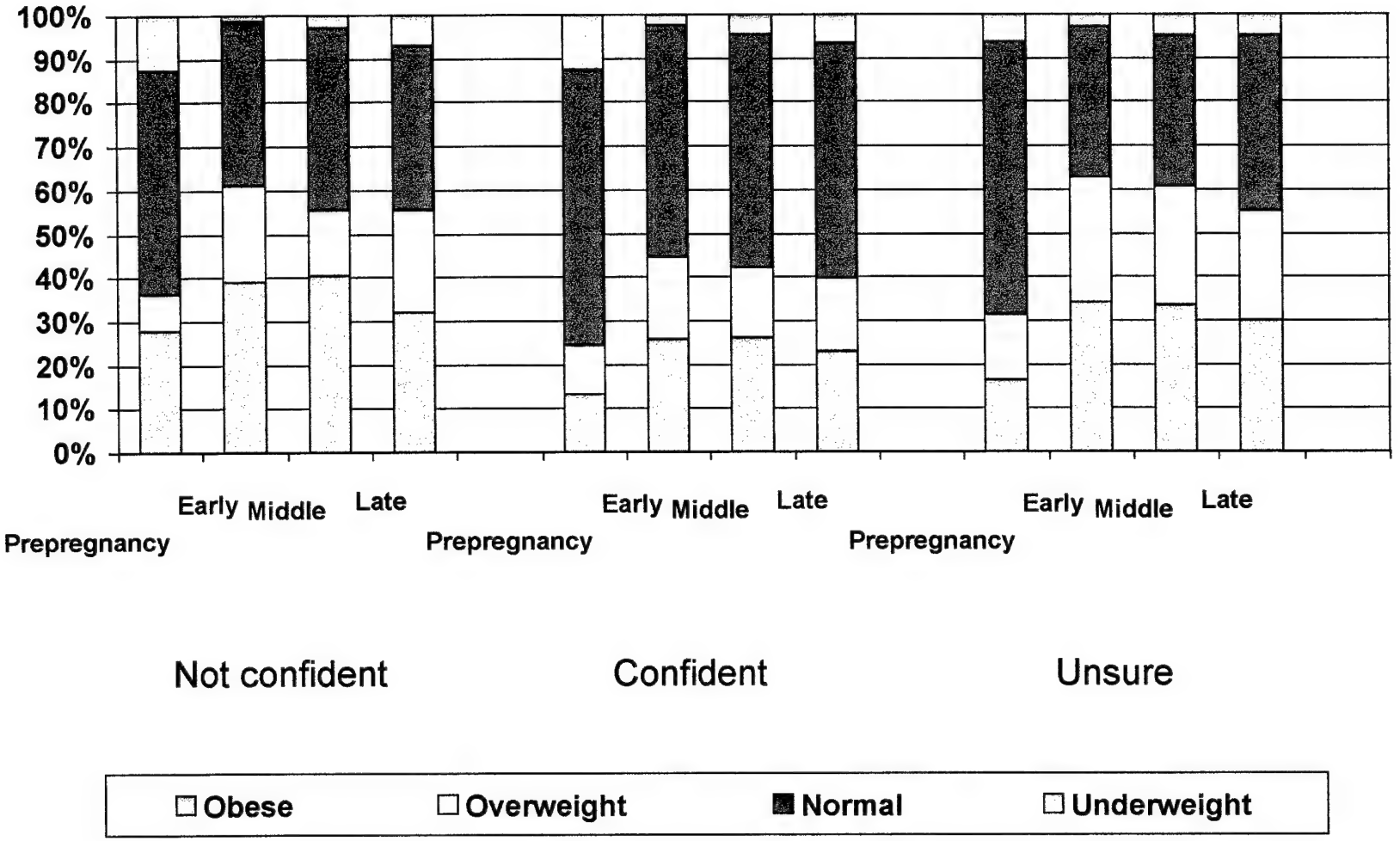


Figure 7. BMI by Active Duty

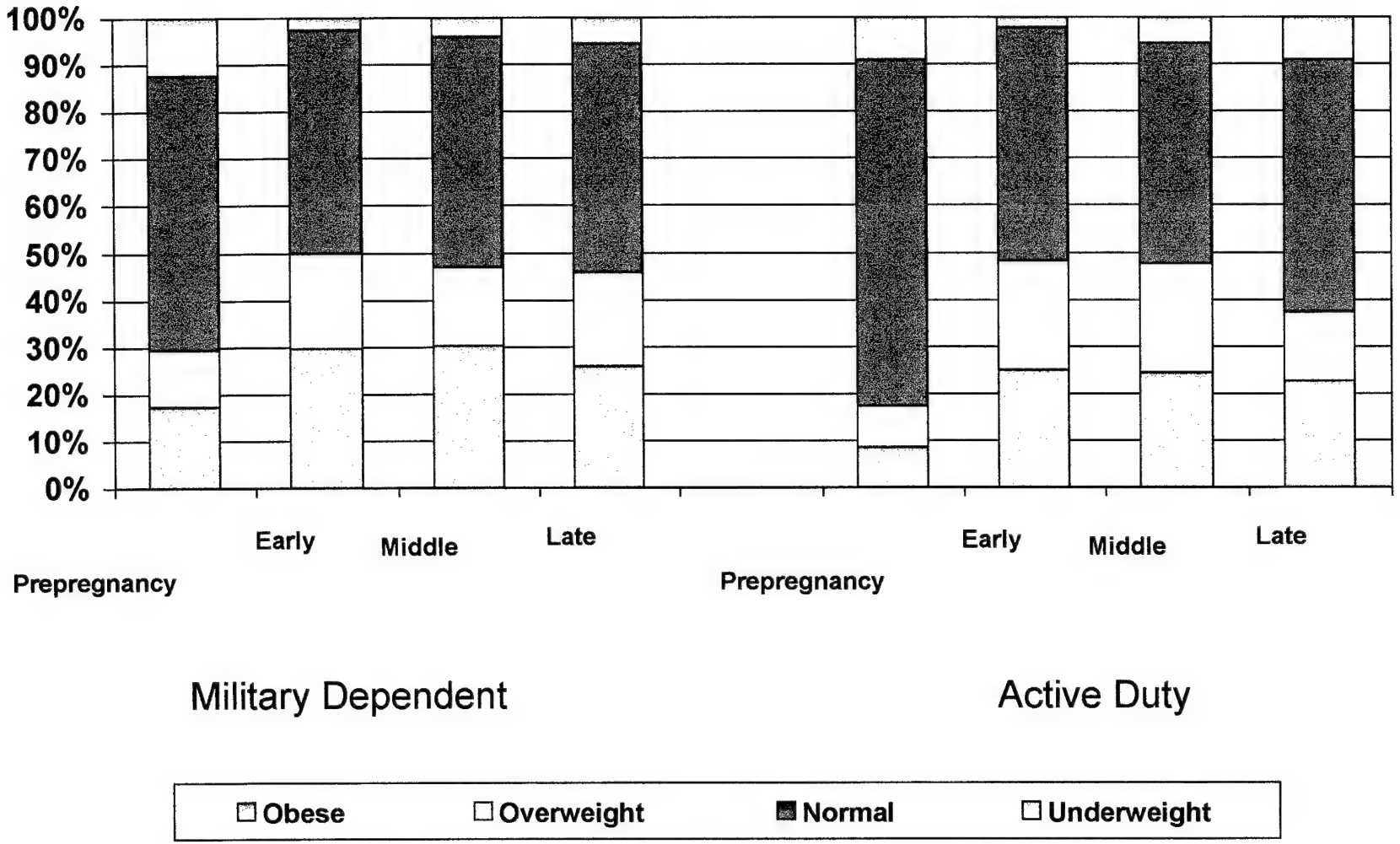


Figure 8. BMI by Weight Cycling

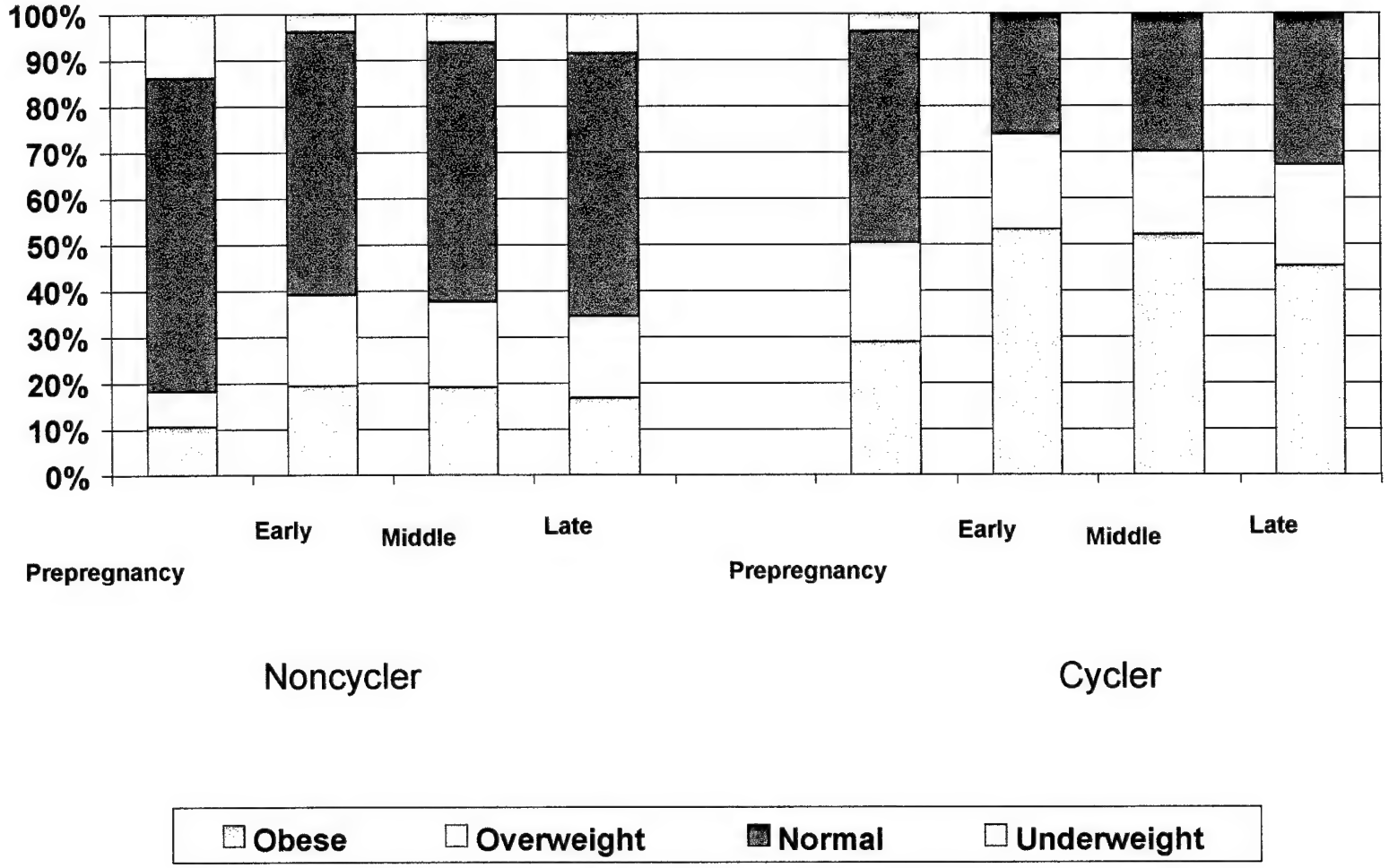


Table 5. Multivariable linear regression of maternal characteristics on postpartum BMI

	Early		Middle		Late	
	b	95% CI	b	95% CI	b	95% CI
Pregnancy gain	0.18	(0.16; 0.20)	0.14	(0.10; 0.18)	0.10	(0.05; 0.14)
Active Duty (versus dependant)	-0.11	(-0.46; 0.24)	-0.48	(-0.99; 0.03)	-0.43	(-1.00; 0.15)
Weight Cycling	0.63	(0.27; 0.98)	0.55	(0.04; 1.06)	0.53	(-0.04; 1.11)
Dieting at 2 months	-0.02	(-0.29; 0.25)	-0.19	(-0.58; 0.20)	-0.65	(-1.11; -0.20)
Infant feeding at early visit (versus all formula)						
Exclusive breastfeeding	-0.27	(-0.58; 0.05)	-0.46	(-0.93; 0.01)	-0.12	(-0.66; 0.42)
Mixed formula and breastfeeding	-0.31	(-0.66; 0.04)	-0.10	(-0.63; 0.43)	-0.08	(-0.67; 0.51)
Able to Pay Bills (versus always)						
Never	0.48	(-0.02; 0.97)	0.42	(-0.33; 1.16)	0.92	(0.08; 1.75)
Sometimes	0.16	(-0.20; 0.51)	0.17	(-0.36; 0.70)	0.18	(-0.42; 0.78)
Race (versus white)						
Black	0.41	(-0.02; 0.84)	0.55	(-0.10; 1.19)	0.75	(0.03; 1.48)
Asian	0.35	(-0.08;0.78)	0.10	(-0.53; 0.73)	0.18	(-0.53; 0.88)
Hispanic	0.19	(-0.18; 0.56)	0.14	(-0.43; 0.70)	0.44	(-0.20; 1.08)
	R^2=0.82		R^2=0.68		R^2=0.61	

*Adjusted for pre-pregnancy BMI, age, parity, and time since birth

Figure 9. BMI by Race (Active Duty)

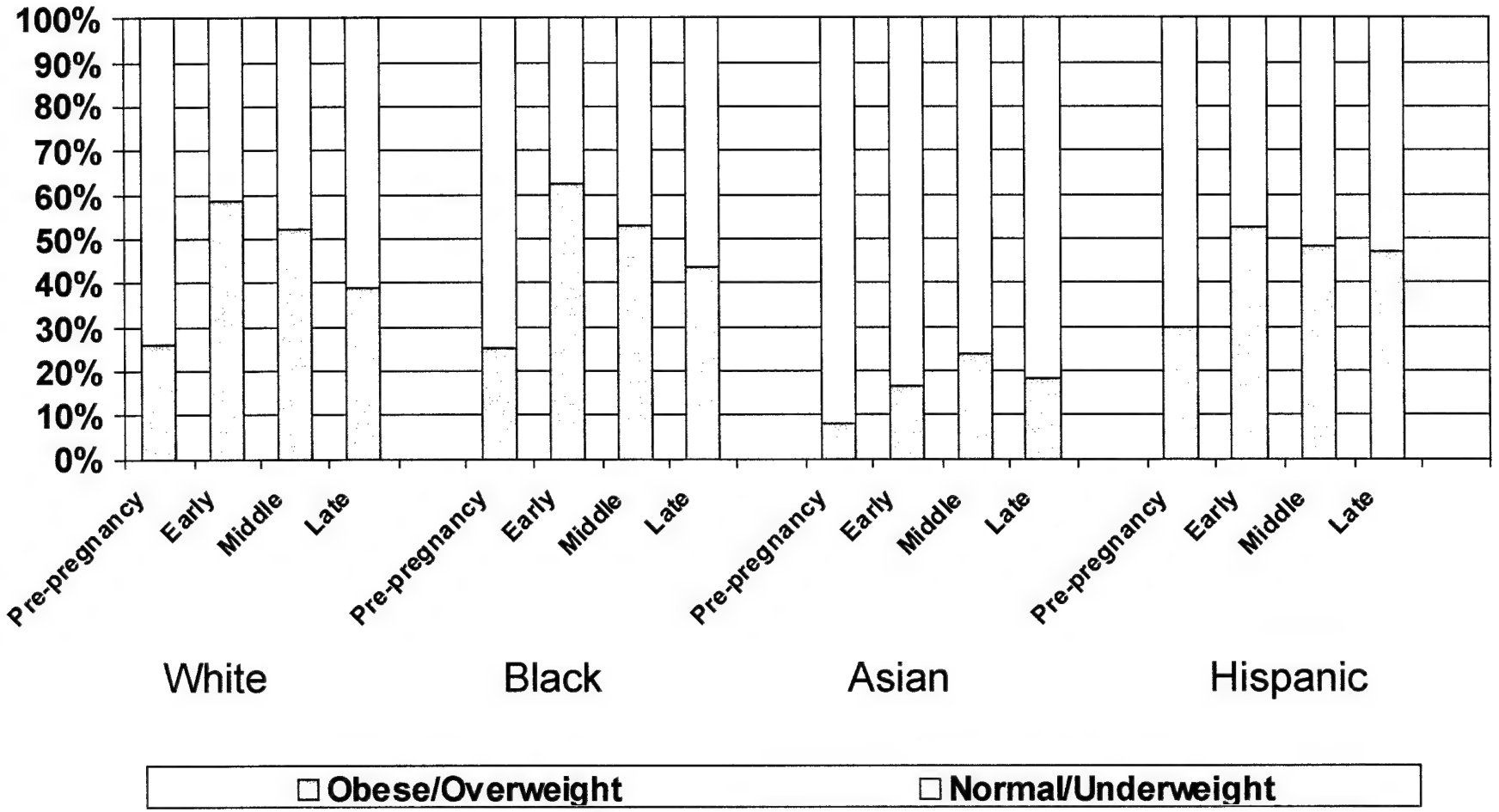


Figure 10. BMI by Prepregnancy BMI (Active Duty women)

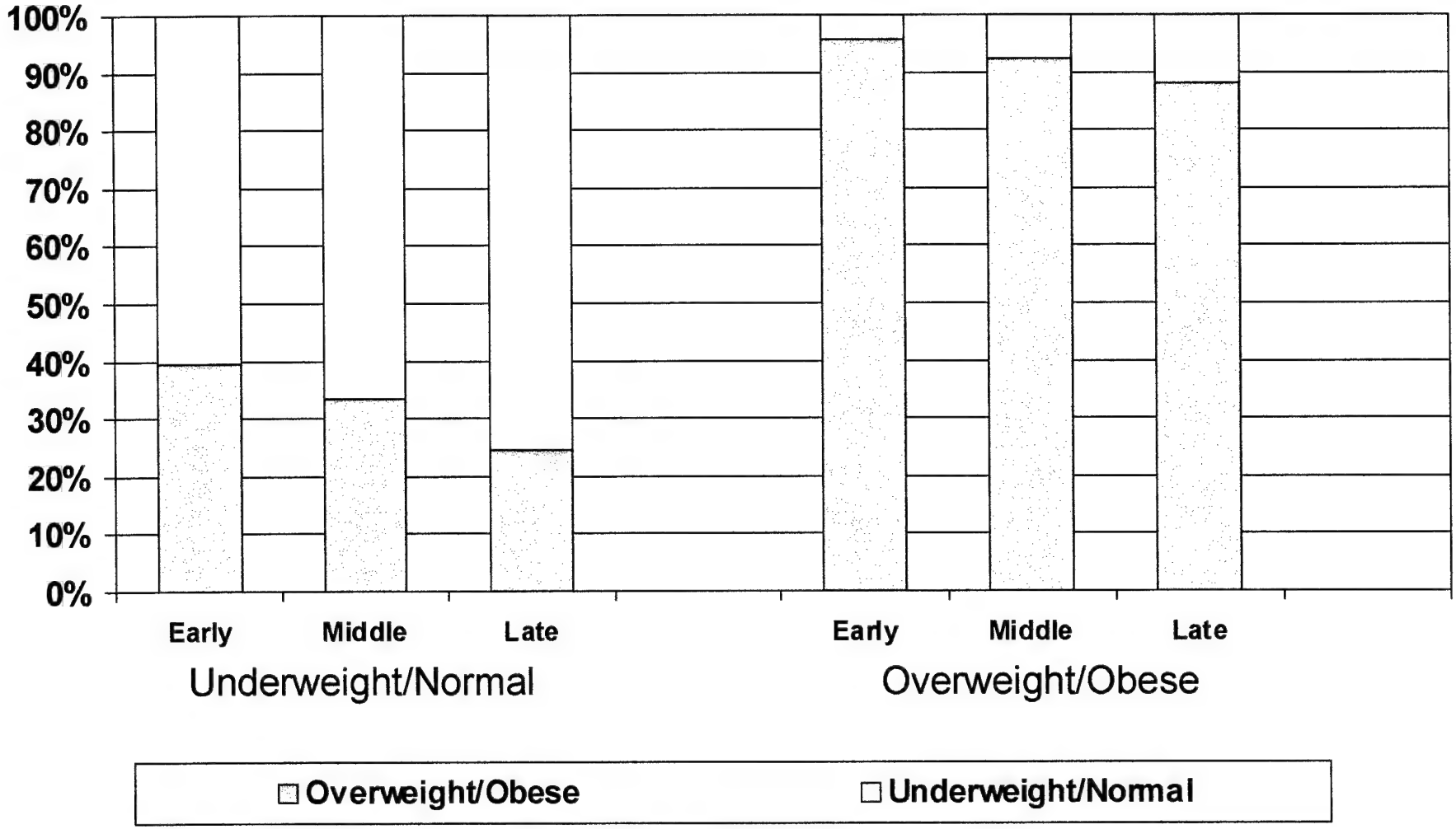


Figure 11. BMI by Gestational Weight Gain (Active Duty women)

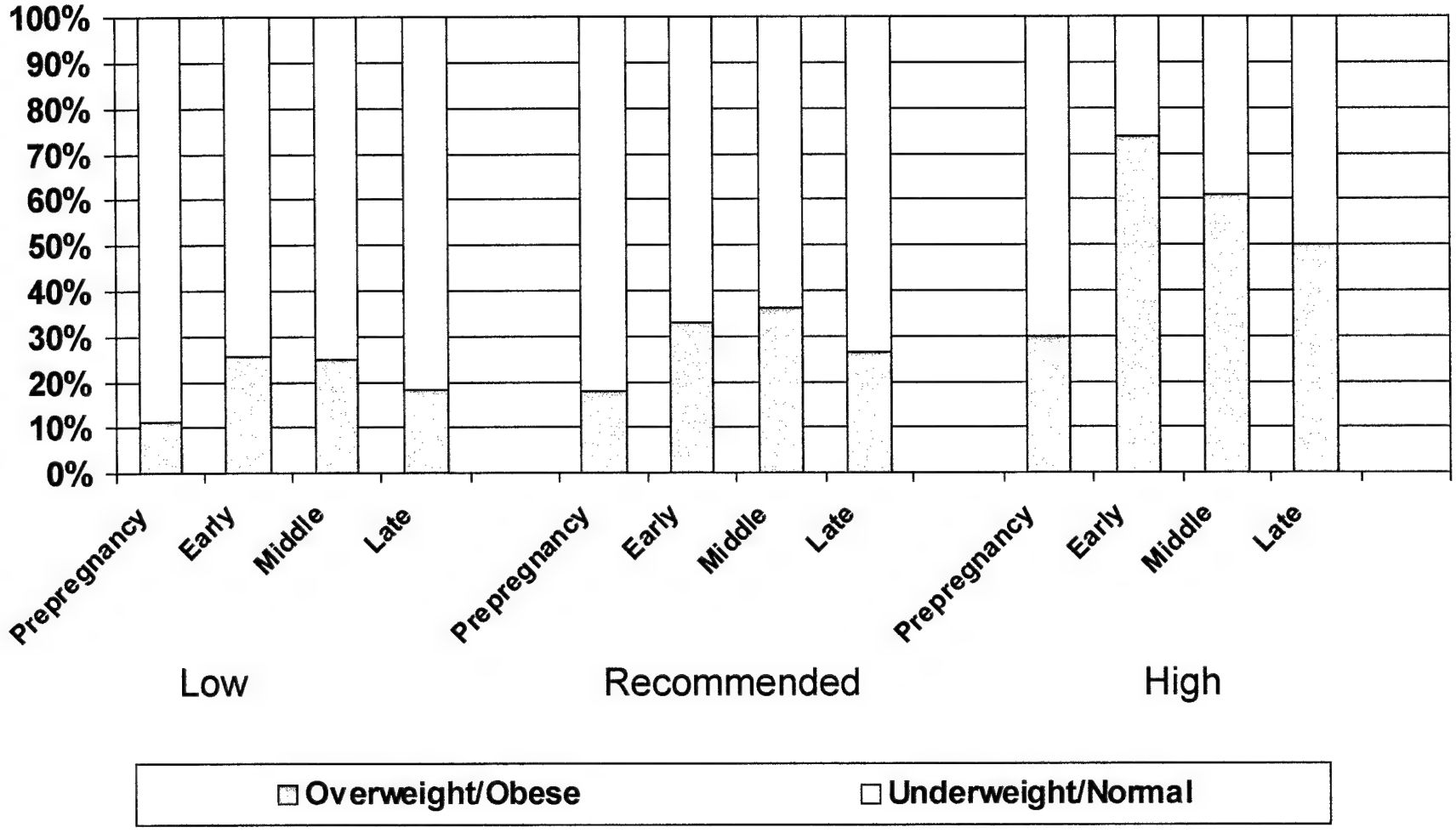


Figure 12. BMI by Confidence about Economic Sufficiency (Active Duty women)

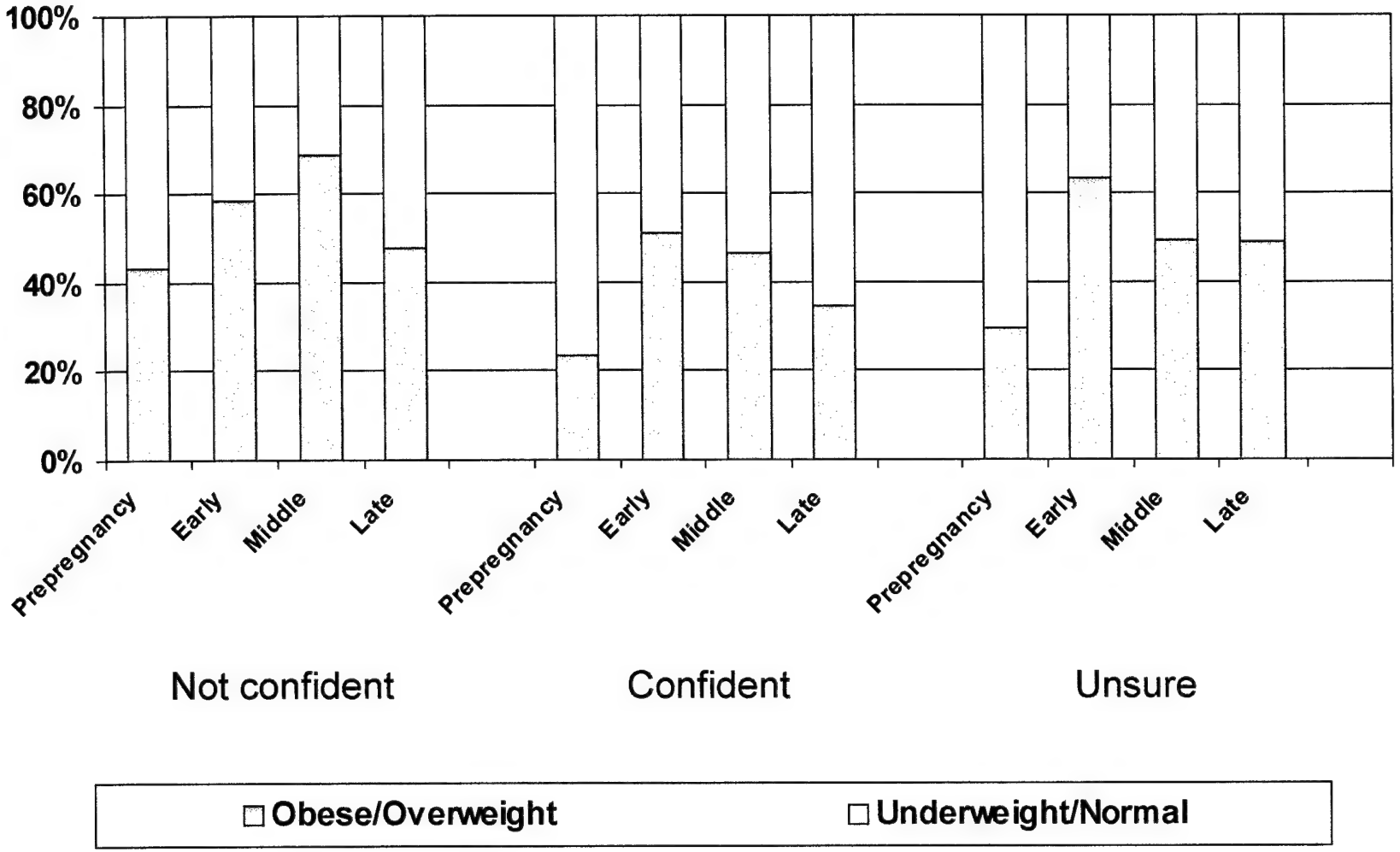


Figure 13. BMI by Weight Cycling (Active Duty women)

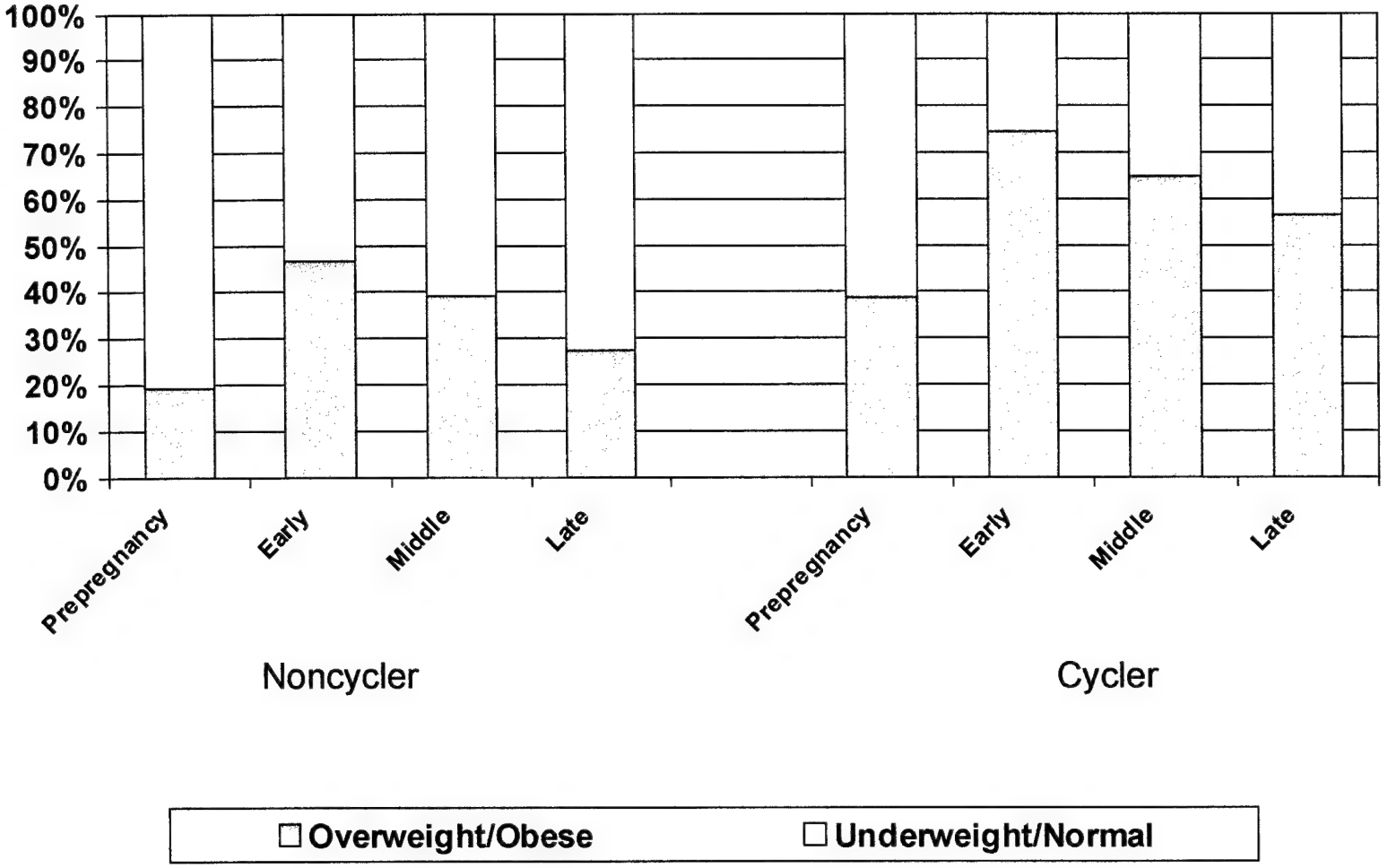


Figure 14. BMI by Early Healthy Dieting Behaviors (Active Duty women)

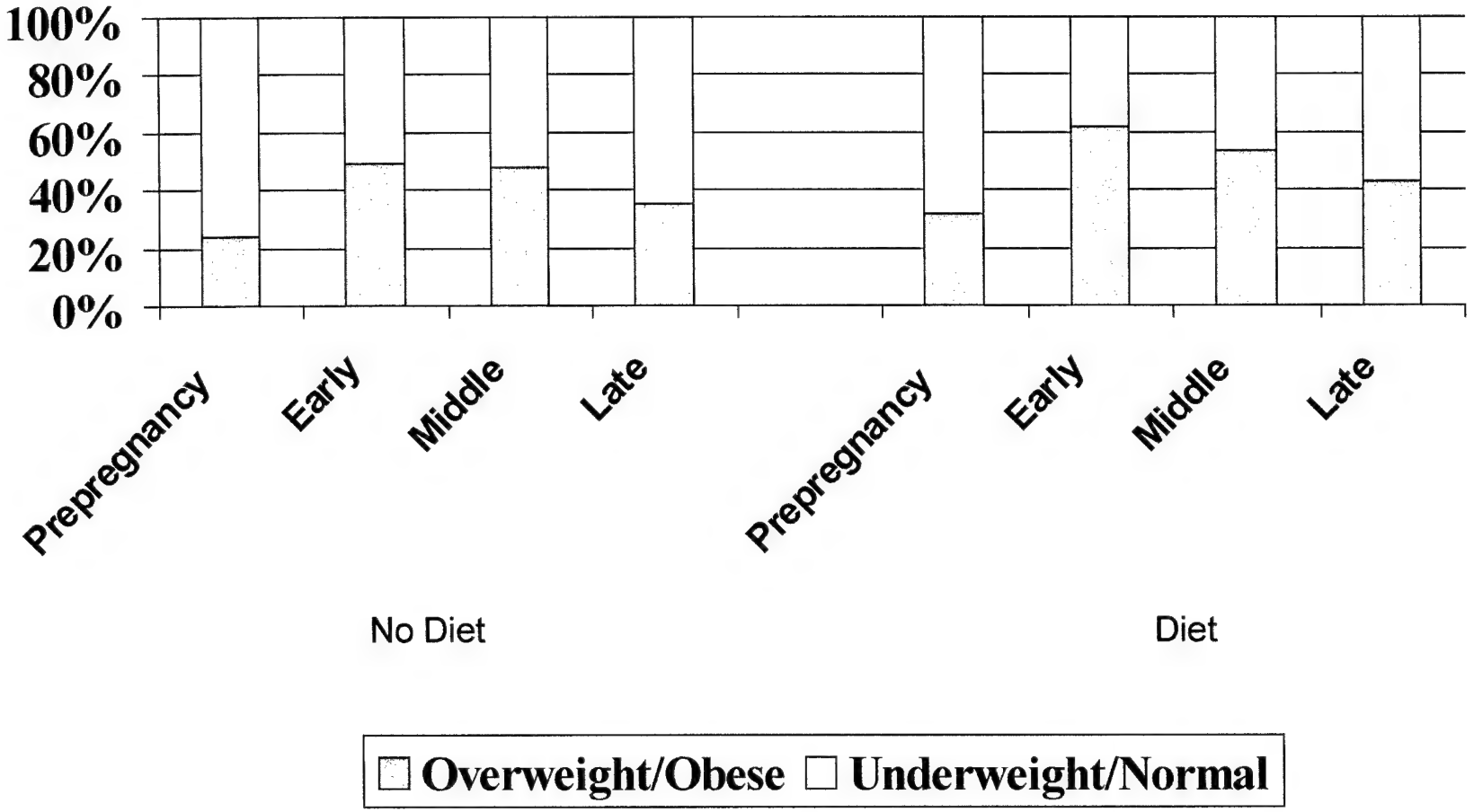


Figure 15. BMI by Amount of Sports (Active Duty women)

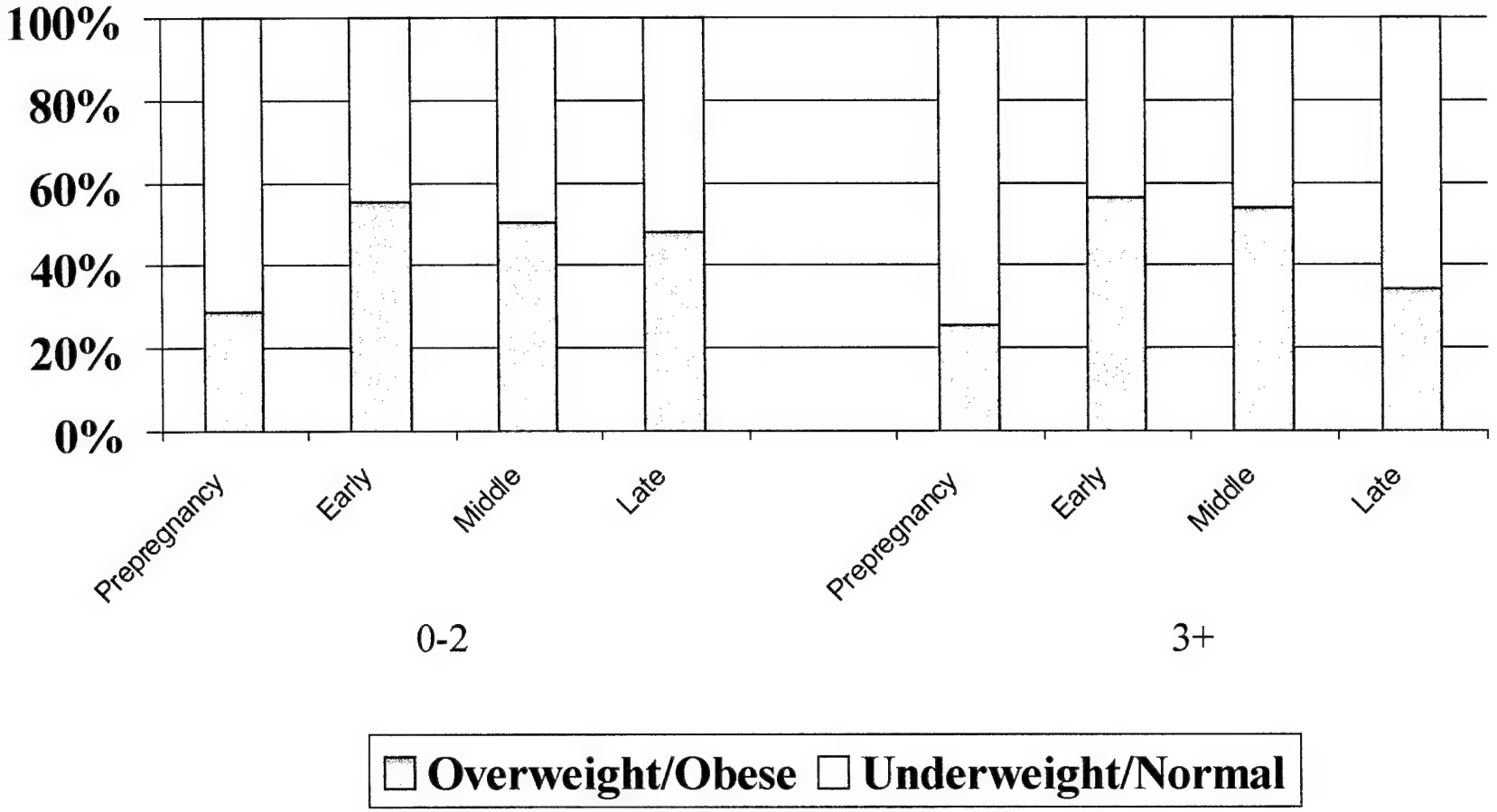


Table 6. Characteristics of the women included in each analysis compared to the eligible study population

Characteristic	Eligible women (731)	Women lost to follow-up (273)	Main Linear Analysis (458)	Sub-Analyses (343)
Maternal Age: mean (se)	26.04 (5.62)	24.92 (4.99)	26.70 (5.87)	26.87 (5.93)
Pre-Pregnancy weight: mean(se)	61.01 (6.70)	60.96 (6.96)	61.05 (6.54)	60.93 (6.72)
Pregnancy weight gain (kg): mean(se)	16.55 (5.50)	16.66 (5.52)	16.50 (5.52)	16.27 (5.40)
Mother's height (cm): mean(se)	163.93 (6.55)	163.77 (6.93)	164.02 (6.32)	164.00 (6.35)
Parity: n (%)				
Primiparous	399 (54.58)	153 (56.04)	246 (53.71)	187 (54.52)
Multiparous	332 (45.42)	120 (43.96)	212 (46.29)	156 (45.48)
Maternal Education: n(%)**				
less than high school	16 (2.9)	5 (3.42)	11 (2.68)	9 (2.62)
high school/GED	173 (31.10)	49 (33.56)	124 (30.17)	101 (29.45)
vocational or trade school	36 (6.50)	10 (6.85)	26 (6.33)	20 (5.83)
some college	274 (49.20)	72 (49.32)	202 (49.15)	166 (48.40)
some graduate school	58 (10.40)	10 (6.85)	48 (11.68)	43 (12.54)
Living with Partner: n(%)				
yes	646 (88.40)	261 (79.12)	430 (93.89)	328 (95.63)
no	85 (11.60)	57 (20.88)	28 (6.11)	15 (4.37)
Naval duty status: n(%)				
active duty	282 (38.60)	120 (43.96)	162 (35.37)	104 (30.32)
non-active duty	449 (61.40)	153 (56.04)	296 (64.63)	239 (69.68)
Estimated household monthly income: mean(se)*	2887.3(1528.5)	2691.5(1383.6)	2961.3(1575.0)	3063.6(1625.7)
History of weight cycling**				
yes	214 (40.80)	44 (33.33)	170 (43.37)	145 (42.27)
no	310 (59.20)	88 (66.67)	222 (56.63)	198 (57.73)
Days of breast feeding: mean(se)	133.81 (117.62)	85.16 (82.67)	158.43 (124.89)	157.20 (122.40)
Race				
African American	162 (22.20)	78 (28.57)	84 (18.34)	57 (16.62)
White	569 (77.80)	195 (71.43)	374 (81.66)	286 (83.38)

*due to missing data the mean income values for the eligible women, the excluded women, the main analysis and the sub-analysis are based on 587, 161, 426, and 337 values respectively

**data on these variables were not available for all women

Table 7. Maternal characteristics by race and duty status

Characteristic	African American active duty (n=44)	White active duty (n=118)	African American non-active duty (n=40)	White non-active duty (n=256)	Full sample (n=458)
Maternal Age: mean (se)	25.84 (5.66)	26.13 (6.03)	25.73 (5.46)	27.26 (5.86)	26.70 (5.87)
Pre-Pregnancy weight: mean(se)	62.10 (6.04)	61.37 (6.76)	61.08 (6.51)	60.71 (6.54)	61.05 (6.54)
Pregnancy weight gain (kg): mean(se)	16.53 (6.41)	17.58 (5.40)	16.17 (5.81)	16.09 (5.30)	16.50 (5.50)
Mother's height (cm): mean(se)	164.19 (6.54)	164.35 (6.76)	162.65 (5.55)	164.05 (6.20)	164.02 (6.32)
Weight retained (kg): mean(se)	3.93 (7.15)	3.23 (5.88)	7.70 (6.65)	2.64 (5.73)	3.36 (6.15)
BMI group postpartum: n(%)					
underweight	3 (6.82)	4 (3.39)	0	4 (1.56)	11 (2.40)
normal	29 (65.91)	85 (72.03)	20 (50.00)	211 (82.42)	345 (73.33)
overweight	8 (18.18)	23 (19.49)	13 (32.50)	32 (12.50)	76 (16.59)
obese	4 (9.09)	6 (5.08)	7 (17.50)	9 (3.52)	26 (5.68)
Parity: n (%)					
Primiparous	24 (54.55)	78 (66.10)	13 (32.50)	131 (51.17)	246 (53.70)
Multiparous	20 (45.45)	40 (33.90)	27 (67.50)	125 (48.83)	212 (46.30)
Maternal Education: n(%)**					
less than high school	1 (2.78)	2 (2.11)	0 (0)	8 (3.27)	11 (2.70)
high school/GED	15 (41.67)	40 (42.11)	9 (25.71)	60 (24.49)	124 (30.20)
vocational or trade school	3 (8.33)	6 (6.32)	4 (11.43)	13 (5.31)	26 (6.30)
some college	15 (41.67)	28 (29.47)	21(60.00)	138 (56.33)	202 (49.10)
some graduate school	2 (5.56)	19 (20.00)	1 (2.86)	26 (10.61)	48 (11.70)
Living with Partner: n(%)					
yes	35 (79.55)	107 (90.68)	37 (92.50)	251 (98.05)	430 (93.90)
no	9 (20.45)	11 (9.32)	3 (7.50)	5 (1.95)	28 (6.10)
Estimated household monthly income: mean(se)**	2554.2(1255.9)	3458.3(1731.3)	1985.7(863.3)	2934.5(1540.7)	2961.3(1575.0)
History of weight cycling**					
yes	11 (33.33)	41 (46.07)	13 (36.11)	104 (44.44)	169 (43.10)
no	22 (66.67)	48 (53.93)	23 (63.89)	130 (55.56)	223 (56.90)
Days of breast feeding: mean(se)	92.66 (103.24)	129.33 (120.69)	159.08 (150.37)	150.25 (129.55)	140.10 (127.92)
Postpartum Dieting: n(%)**					
yes	24 (72.73)	74 (77.08)	26 (76.47)	169 (76.47)	293 (76.30)
no	9 (27.27)	22 (22.92)	8 (23.53)	52 (23.53)	91 (23.70)

*data on these variables were not available for all women

Table 8. Multivariable linear regression of maternal characteristics on weight retention

Characteristic			
Characteristic	coefficient*	(se)	p-value
Living with partner	-1.070	1.200	0.3721
Parity	0.660	0.380	0.0900
Age (years)	-0.110	0.050	0.0300
Days since birth	0.004	0.004	0.3974
African American active duty status**	1.051	1.004	0.2959
African American non-active duty status	4.622	1.034	0.0001
White active duty status	0.516	0.681	0.4484

*coefficients correspond to the difference in kg of weight retention with respect to baseline

**coefficients for race and active duty categories are computed with respect to white non-active duty women

Table 9. Multivariable linear regression of maternal characteristics on weight retention

Results for the sub analysis sample (n=337)			
Characteristic	coefficient*	(se)	p-value
Living with partner	0.968	1.564	0.5360
Parity	0.643	0.424	0.1300
Age (years)	-0.075	0.069	0.2790
Days since birth	-0.008	0.005	0.1060
African American active duty status**	-1.281	1.237	0.3010
African American non-active duty status	4.169	1.095	0.0002
White active duty status	0.573	0.777	0.4619
Household monthly income (per $100 dollars)	-0.027	0.020	0.2779
History of weight cycling	1.764	0.623	0.0049
Excercise (number of times)	-0.040	0.131	0.7613
Dieting	0.738	0.714	0.3019

*coefficients correspond to the difference in kg of weight retention with respect to baseline

**coefficients for race and active duty categories are computed with respect to white non-active duty women

Table 10. Demographic characteristics of the study population, dieting practices sample, and weight retention sample

	N Study group (n=1253)	N (%)	Mean (SD)	N Dieting practices group (n=597)	N (%)	Mean (SD)	N Weight retention group (n=337)	N (%)	Mean (SD)
Weight retention (kg)*									
Month 2	606		7.4 (5.8)	596		7.2 (4.6)	337		6.8 (4.4)
Month 4/6	449		6.4 (8.5)	443		5.9 (5.4)	337		5.5 (5.0)
Month 9/12	420		4.6 (9.3)	414		4.4 (6.0)	337		4.0 (5.7)
Age (y)	1245		26.0 (5.6)	593		25.8 (5.4)	336		26.3 (5.5)
Pre-pregnancy weight (kg)	1253		59.4 (6.8)	597		59.4 (6.9)	337		59.4 (6.9)
Pre-pregnancy BMI (kg/m^2)	1253		22.6 (1.7)	597		22.6 (1.6)	337		22.5 (1.6)
Race/ethnicity (%)	1253			597			337		
Caucasian		668 (53.3)			317 (53.1)			194 (57.6)	
African-American		181 (14.4)			80 (13.4)			43 (12.8)	
Asian		50 (4.0)			22 (3.7)			14 (4.2)	
Filipino		137 (10.9)			70 (11.7)			39 (11.6)	
Hispanic		217 (17.3)			108 (18.1)			47 (13.9)	
Nulliparous prior to study	1084	568 (52.4)		561	311 (55.4)		315	176 (55.9)	
Average monthly income ($)	998		2102 (1143)[b]	476		2083 (1128)	298		2269 (1263)[a]
Education	1015			483			305		
Didn't complete high school		46 (4.5)			19 (3.9)			9 (3.0)	
Completed high school/GED		311 (30.6)			146 (30.2)			84 (27.5)	
Vocational school		65 (6.4)			26 (5.4)			12 (3.9)	
College		495 (48.8)			248 (51.3)			167 (54.8)	
Graduate school		98 (9.7)			44 (9.1)			33 (10.8)	
Married/living with partner (%)	1253	1151 (91.9)		597	551 (92.3)		337	311 (92.3)	
Active duty (%)	1253	444 (35.4)		597	211 (35.3)		337	111 (32.9)	
Smoker at baseline (%)	946	153 (16.2)[b]		470	72 (15.3)		298	34 (11.4)[a]	
History of weight cycling (%)	669	336 (50.2)[b]		326	139 (42.6)[a]		204	87 (42.6)	
Exclusive breastfeeding at 2.5 months postpartum (%)	689	80 (11.6)		314	37 (11.9)		154	14 (9.1)	

* Weight retention among women who had weight left to lose at month 2.5

Values within a row with different superscript letters are significantly different (p-value<0.05)

Table 11. Overall prevalence of maternal weight control practices at month 2.5 postpartum

	All* (n=597)	%
Specific behaviors		
	Ate less food/Followed a low calorie diet [a]	45.7
	Tried to be more physically active [a]	40.5
	Avoided junk foods [a]	38.0
	Did nothing [b]	24.8
	Used low fat foods [a]	23.3
	Skipped meals [c]	19.4
	Drank diet soft drinks	12.6
	I worried but did nothing [b]	6.8
	Smoked cigarettes [c]	5.4
	Meal replacements	4.0
	Took weight loss pills	2.7
	Used herbal medications	2.2
	Relaxation, visualization, meditation, or stress reduction techniques	1.7
	Fasted for at least one day [c]	1.7
	Received nutrition counseling from a dietitian or nutritionist	1.0
	Took diuretics or water pills [c]	0.8
	Received nutrition counseling from another health care provider	0.4
	Participated in military-sponsored weight loss programs	0.3
	Intentionally vomited after eating [c]	0.3
	Liposuction	0.2
	Participated in organized weight loss programs	0.2
	Took laxatives to lose weight [c]	0.2

Two behaviors, "Hypnosis, biofeedback, etc." and "Psychotherapy or behavior modification" were not reported by any women
***All women surveyed at two months regardless of follow-up weight information**
[a] healthy behaviors
[b] did nothing
[c] unhealthy behaviors

Table 12. Predictors of maternal dieting at month 2.5 postpartum (n=597)

Variable		Unadjusted OR [a]	95% CI	Adjusted OR [b]	95% CI
Age (per 5 years)		1.12	0.96-1.30	1.17	0.72-1.90
Pre-Pregnancy weight (per 10 lb.)		1.18	0.93-1.50	1.01	0.47-2.15
Pre-Pregnancy BMI (per 1 kg/m^2)		1.04	0.95-1.15	1.05	0.75-1.47
Race	White	1.00	--	1.00	--
	Black	0.55*	0.33-0.90	0.29*	0.08-1.00
	Asian	0.76	0.32-1.81	0.27	0.18-2.22
	Filipino	0.57*	0.34-0.97	0.63	0.18-4.69
	Hispanic	0.94	0.61-1.46	1.60	0.54-4.69
Parity at baseline	Nulliparous	1.00	--	1.00	--
	Parous	0.76	0.54-1.06	0.93	0.37-2.35
Monthly household income (per $1000)		1.08	0.92-1.27	0.92	0.72-1.18
Education	< HS	0.89	0.35-2.25	1.91	0.06-57.82
	HS/GED/Vocational/trade school	0.76	0.52-1.11	1.74	0.69-4.39
	College/Grad school	1.00	--	1.00	--
Married/living with partner		1.12	0.61-2.05	0.61	0.11-3.48
Active duty		0.84	0.60-1.18	1.13	0.45-2.82
History of weight cycling		1.06	0.68-1.64	1.00	0.45-2.24
Smoking status	Former/non-smoker	1.00	--	1.00	--
	Current smoker	0.36*	0.20-0.63	0.17*	0.05-0.56
Infant feeding method	Breastfeeding only	0.91	0.46-1.83	0.95	0.29-3.17
	Mixed breastfeeding and bottle	0.97	0.53-1.74	1.95	0.64-5.98
	Bottle only	1.00	--	1.00	--

[a] Univariate logistic regression model for each variable

[b] Multiple logistic regression, simultaneously adjusted for all other variables listed in the table

* p-value<0.05

Figure 16. Patterns of Postpartum Weight Retention by Race

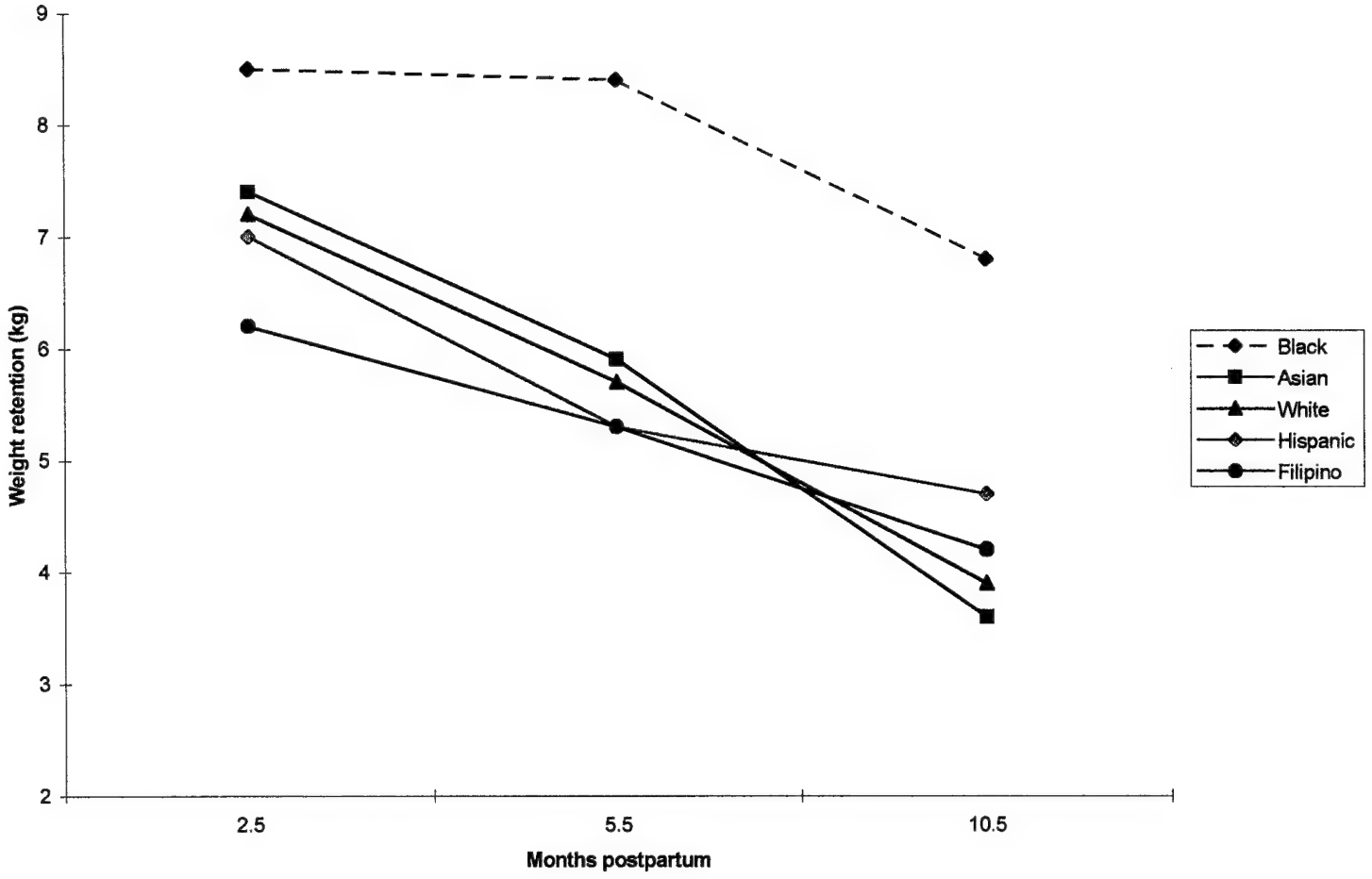


Figure 17. Patterns of Weight Retention in Black and non-Black Women by Dieting Status

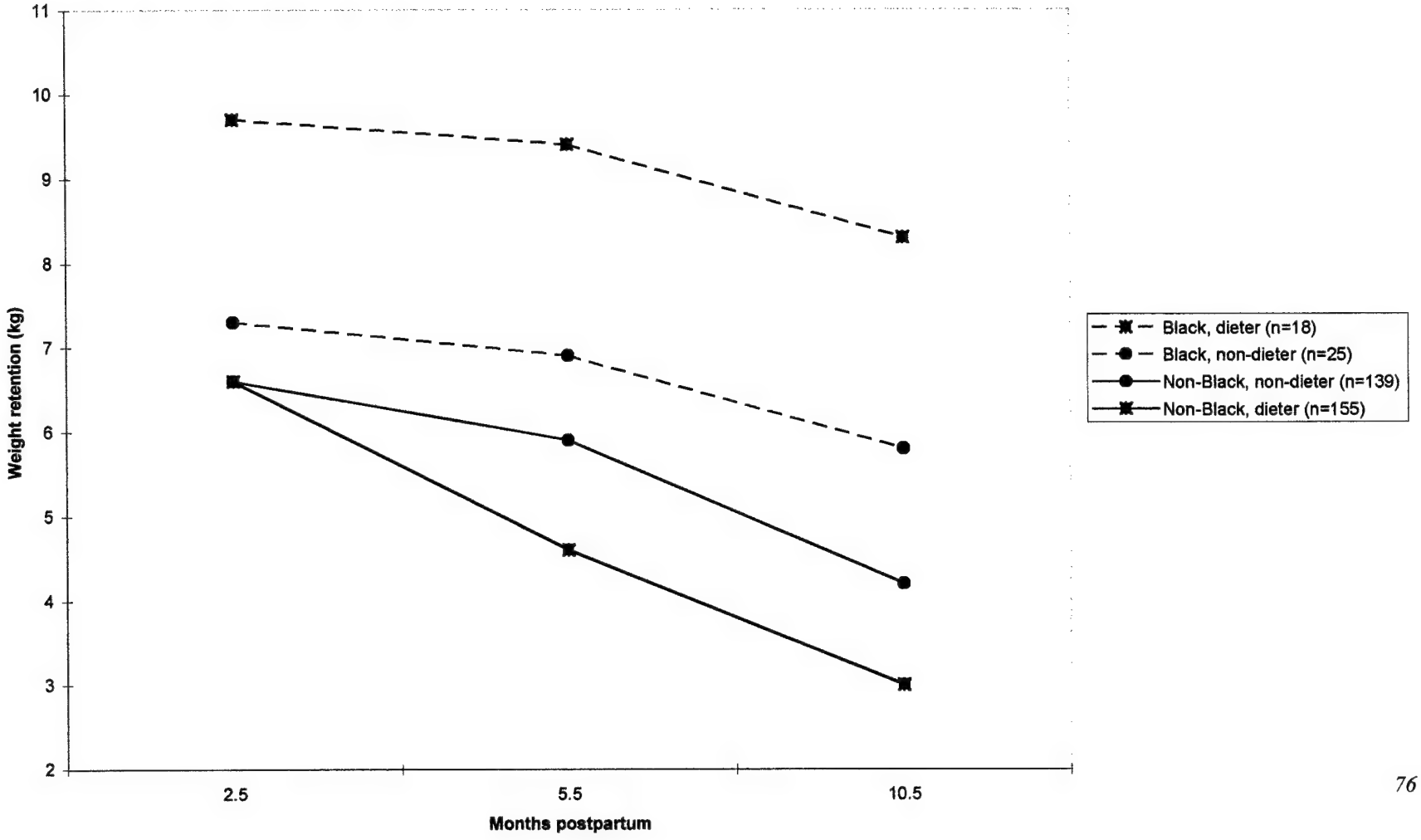


Table 13. Prevalence of maternal dieting practices at month 2.5 postpartum among Black and non-Black women

		Non-Black (n=517) %	Black (n=80) %
Specific behaviors			
	Ate less food/Followed a low calorie diet [a]	47.4	35.0*
	Tried to be more physically active [a]	41.4	35.0
	Avoided junk foods [a]	41.4	16.3*
	Did nothing [b]	22.6	38.8*
	Used low fat foods [a]	26.1	5.0*
	Skipped meals [c]	19.0	22.5
	Drank diet soft drinks	13.7	5.0*
	I worried but did nothing [b]	7.3	3.4
	Smoked cigarettes [c]	5.4	5.1
	Meal replacements	4.5	1.3
	Took weight loss pills	3.1	0.0
	Used herbal medications	1.9	3.8
	Relaxation, visualization, meditation, or stress reduction techniques	1.7	1.3
	Fasted for at least one day [c]	1.4	3.8
	Received nutrition counseling from a dietitian or nutritionist	0.7	3.4
	Took diuretics or water pills [c]	1.0	0.0
	Received nutrition counseling from another health care provider	0.5	0.0
	Participated in military-sponsored weight loss programs	0.4	0.0
	Intentionally vomited after eating [c]	0.4	0.0
	Liposuction	0.2	0.0
	Participated in organized weight loss programs	0.2	0.0
	Took laxatives to lose weight [c]	0.2	0.0

Two behaviors, "Hypnosis, biofeedback, etc." and "Psychotherapy or behavior modification" were not reported by any women

*** p-value<0.05**

[a] healthy behaviors

[b] did nothing [c] unhealthy behavior

Table 14. Demographic characteristics of women in the study group compared to women in the analytic sample

	N Study Group (n=1667)	N	(%)	Mean	(SD)	N Analytic Sample (n=1039)	N	(%)	Mean	(SD)
Depression										
Mean score at Month 2	1281			13.0	(9.9)				12.7	(9.9)
Mean score at Month 12	652			11.9	(9.9)				11.6	(9.9)
CES-D score>15 at Month 2 (%)	1281	418	(32.6)			1039	331	(31.9)		
CES-D score>15 at Month 12 (%)	652	171	(26.2)			421	105	(24.9)		
Overall social support (1-4 score)	1644			1.90	(0.70)	1039			1.90	(0.71)
Pre-pregnancy weight (kg)	1667			64.1	(13.2)	1039			64.3	(13.2)
Gestational weight gain (kg)	1352			15.9	(7.5)	839			15.8	(7.6)
Postpartum weight (kg)	1667			69.2	(14.8)	1039			69.4	(14.7)
Weight retention (kg)	1667			5.1	(6.3)	1039			5.2	(6.2)
Pre-pregnancy BMI (kg/m**2) (%)	1667			24.3	(4.6)	1039			24.4	(4.6)
Normal weight (BMI<25)		1205	(72.3)				741	(71.3)		
Overweight (BMI>=25)		462	(27.7)				298	(28.7)		
Postpartum BMI (kg/m**2) (%)	1667			26.3	(5.2)	1039			26.4	(5.2)
Normal weight (BMI<25)		928	(55.7)				561	(54.2)		
Overweight (BMI>=25)		739	(44.3)				475	(45.8)		
Time since birth (weeks)	1667			35.2	(17.6)	1039			35.1	(17.3)
Age (%)	1660			25.8	(5.5)	1039			26.1	(5.4)
<20		138	(8.3)				68	(6.5)		
20-30		1116	(67.2)				705	(67.9)		
>30		406	(24.5)				266	(25.6)		
Parity (%)	1559					1039				
0		722	(46.3)				514	(50.0)		
1		533	(34.2)				348	(33.8)		
2		217	(13.9)				126	(12.2)		
3		59	(3.8)				27	(2.6)		
4		27	(1.7)				14	(1.4)		
Race / ethnicity (%)	1659					1039				
White		934	(56.3)				619	(59.6)		
Black		238	(14.4)				139	(13.4)		
Asian		182	(11.0)				114	(11.0)		
Hispanic		258	(15.6)				167	(16.1)		
Other		46	(2.8)							
Monthly household income (%)	1442			2030	(1070.0)	1039			2104	(1112.0)
1-500		10	(0.7)				7	(0.7)		
501-1000		88	(6.1)				51	(4.9)		
1001-1500		234	(16.2)				154	(14.8)		
1501-2000		295	(20.5)				212	(20.4)		
2001-2500		276	(19.1)				208	(20.0)		
2501-3000		201	(13.9)				147	(14.1)		
3001-6250		296	(20.5)				222	(21.4)		
>6250		42	(2.9)				38	(3.7)		
Education (%)	1462					1039				
Didn't complete high school		67	(4.6)				36	(3.5)		
Completed high school/GED		470	(32.1)				331	(31.9)		
Vocational school		111	(7.6)				78	(7.5)		
Any college		706	(48.3)				513	(49.4)		
Graduate school		108	(7.4)				81	(7.8)		
Rank (%) Ω	1661					1039				
E1-E4: Junior Enlisted Personnel		811	(48.9)				494	(47.5)		
E5-E9: Senior Enlisted Personnel		630	(37.9)				387	(37.2)		
W1-O4: Junior Officer		143	(8.6)				102	(9.8)		
O5-O9: Senior Officer		77	(4.6)				56	(5.4)		
Active Duty at Baseline (%)	1667	408	(24.5)			1039	254	(24.4)		
Married/living with partner (%)	1667	1522	(91.3)			1039	971	(93.5)		

Ω Participants rank if active duty, otherwise spouse's rank

Figure 18. Weight retention by average social support measure

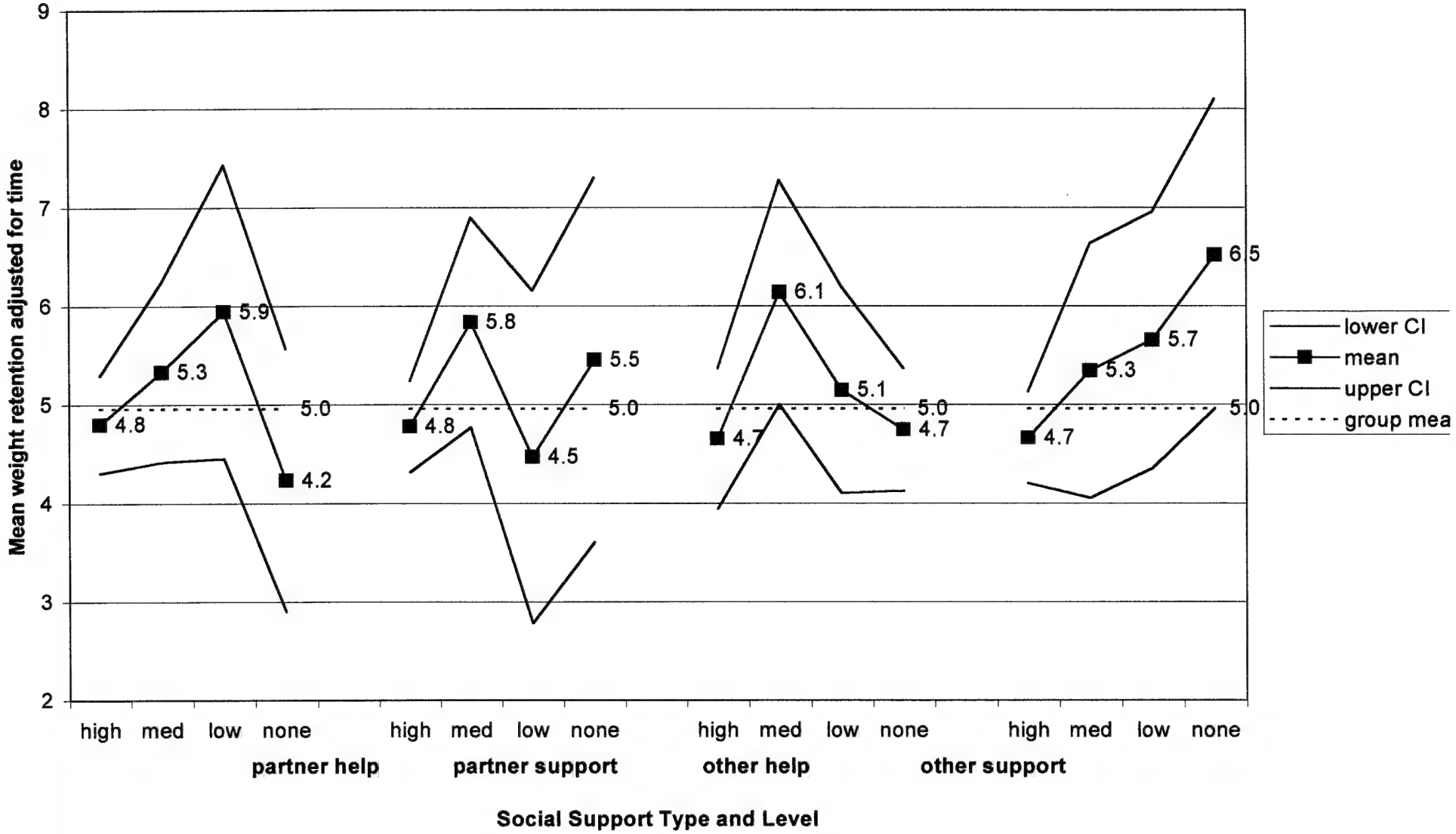


Table 15. Univariate predictors of postpostpartum weight retention, adjusted for time of measure

	Group (n=1667)	Weight Retention	SD	Test Statistic	p-value
Baseline depression	1282			F=9.57	0.002
CES-D<15 at Month 2	864	4.7	(0.20)		
CES-D>15 at Month 2	418	5.9	(0.30)		
Follow-up depression	652			F=0.10	0.7503
CESD<15 at Month 12	481	5.0	(0.19)		
CESD>15 at Month 12	171	4.9	(0.47)		
Pre-pregnancy BMI	1667			F=5.07	0.0017
Under weight	193	4.6	(0.45)		
Normal weight	1013	5.2	(0.20)		
Over weight	231	6.2	(0.41)		
Obese	232	4.0	(0.41)		
Age	1660			F=9.68	0.0001
<20	138	7.2	(0.53)		
20-30	1117	5.1	(0.19)		
>30	406	4.5	(0.31)		
Parity	1558			F=1.97	0.0974
0	723	5.5	(0.23)		
1	533	4.6	(0.27)		
2	217	4.9	(0.42)		
3	59	5.1	(0.81)		
4	27	6.7	(1.20)		
Race / ethnicity (%)	1659			F=1.51	0.1964
White	935	5.0	(0.21)		
Black	238	5.6	(0.41)		
Asian	182	4.5	(0.47)		
Hispanic	258	5.6	(0.39)		
Other	46	4.2	(0.93)		
Monthly household income	1442			F=3.65	0.0007
1-500	10	6.4	(1.93)		
501-1000	88	6.9	(0.65)		
1001-1500	234	5.7	(0.40)		
1501-2000	295	5.6	(0.36)		
2001-2500	276	5.3	(0.37)		
2501-3000	202	4.0	(0.43)		
3001-6250	296	4.3	(0.36)		
>6250	42	4.0	(0.94)		
Education (%)	1463			F=3.08	0.0155
Didn't complete high school	67	6.3	(0.75)		
Completed high school/GED	471	5.7	(0.28)		
Vocational school	111	4.6	(0.58)		
Any college	706	4.9	(0.23)		
Graduate school	108	3.8	(0.59)		
Rank Ω	1662			F=2.45	0.0621
E1-E4: Junior Enlisted Personnel	812	5.3	(0.22)		
E5-E9: Senior Enlisted Personnel	630	5.2	(0.25)		
W1-O4: Junior Officer	143	3.9	(0.52)		
O5-O9: Senior Officer	77	4.2	(0.72)		
Active Duty	1667			F=0.72	0.3955
Yes	408	5.3	(0.31)		
No	1259	5.0	(0.18)		
Married/Living with partner	1667			F=0.49	0.4825
Yes	1522	5.1	(0.16)		
No	145	5.4	(0.52)		

Ω Participants rank if active duty, otherwise spouse's rank

Table 16. Key demographic factors and adjusted weight retention by race/ethnicity

	White women (n=619)		Black women (n=139)		Asian women (n=114)		Hispanic women (n=167)	
Continuous covariates by race/ethnicity	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Depression								
Mean score at Month 2	12.3	(10.0)	13.2	(9.2)	13.0	(9.3)	13.6	(10.3)
Mean score at Month 12	11.3	(10.1)	12.0	(10.3)	12.0	(8.0)	12.3	(10.4)
Overall social support (1-4 score)	1.88	(0.67)	1.95	(0.74)	1.78	(0.69)	2.02	(0.80)
Pre-pregnancy weight (kg)	65.8	(12.8)	67.0	(14.3)	54.5	(10.0)	63.2	(12.3)
Gestational weight gain (kg)	15.6	(7.2)	15.9	(6.0)	15.3	(6.1)	16.4	(7.5)
Postpartum weight (kg)	71.0	(14.6)	72.5	(15.1)	59.3	(12.1)	68.5	(13.7)
Postpartum weight retention (kg)	5.2	(6.1)	5.5	(7.0)	4.9	(5.3)	5.3	(6.5)
Pre-pregnancy BMI (kg/m**2)	24.5	(4.5)	25.2	(5.2)	22.5	(3.4)	25.0	(4.8)
Postpartum BMI (kg/m**2)	26.4	(5.1)	27.2	(5.5)	24.5	(4.1)	27.1	(5.2)
Time since birth (weeks)	36.3	(17.7)	32.6	(16.1)	34.1	(17.0)	33	(16.4)
Age	26.2	(5.5)	26.0	(5.2)	28.5	(5.4)	24.4	(4.6)
Monthly household income	2251	(1190)	1866	(879)	2135	(1012)	1734	(926)
Categorical covariates by race/ethnicity	N	(%)	N	(%)	N	(%)	N	(%)
Depression								
CESD score>15 at Month 2	188	(30.4)	45	(32.4)	36	(31.6)	62	(37.1)
CESD score>15 at Month 12	60	(23.1)	18	(31.6)	10	(23.3)	17	(27.9)
Normal weight prepregnancy (BMI<25)	438	(70.8)	89	(64.0)	99	(86.8)	115	(68.9)
Overweight prepregnancy (BMI>=25)	181	(29.2)	50	(36.0)	15	(13.2)	52	(31.1)
Normal weight postpartum (BMI<25)	340	(54.9)	62	(44.6)	80	(70.2)	82	(49.1)
Overweight postpartum (BMI>=25)	279	(45.1)	77	(55.4)	34	(29.8)	85	(50.9)
Parity								
0	314	(50.7)	61	(43.9)	58	(50.9)	81	(48.5)
1	202	(32.6)	50	(36.0)	38	(33.3)	58	(34.7)
2	73	(11.8)	19	(13.7)	12	(10.5)	22	(13.2)
3	22	(3.6)	6	(4.3)	4	(3.5)	5	(3.0)
4	8	(1.3)	3	(2.2)	2	(1.8)	1	(0.6)
Education (%)								
Didn't complete high school	23	(3.7)	2	(1.4)	2	(1.8)	9	(5.4)
Completed high school/GED	204	(34.2)	40	(29.2)	20	(17.9)	67	(42.4)
Vocational school	49	(7.4)	11	(6.4)	7	(5.3)	11	(5.6)
Any college	288	(34.2)	81	(37.5)	69	(36.9)	75	(32.8)
Graduate school	55	(8.8)	5	(3.5)	16	(12.6)	5	(3.0)
Rank Ω								
E1-E4: Junior Enlisted Personnel	273	(44.1)	76	(54.7)	41	(36.0)	104	(62.3)
E5-E9: Senior Enlisted Personnel	227	(36.7)	54	(38.8)	61	(53.5)	45	(26.9)
W1-O4: Junior Officer	73	(11.8)	6	(4.3)	9	(7.9)	14	(8.4)
O5-O9: Senior Officer	46	(7.4)	3	(2.2)	3	(2.6)	4	(2.4)
Active Duty at Baseline	139	(22.5)	32	(23.0)	32	(28.1)	51	(30.5)
Married/living with partner	589	(95.2)	119	(85.6)	105	(92.1)	158	(94.6)

Adjusted mean postpartum weight retention by race/ethnicity		Mean	Mean	Mean	Mean
Low social support	Depressed	4.5	7.9	5.5	6.5
	Not depressed	4.1	6.4	4.3	5.2
High social support	Depressed	3.5	5.9	0.5	2.2
	Not depressed	3.1	4.4	-0.7	0.9
Difference between high and low		1.3	3.5	6.2	5.5

Ω Participants rank if active duty, otherwise spouse's rank

Table 17. Predictors of maternal postpartum weight stratified by race

	All Women** (n=1039) coefficient Ψ	White women (n=619) coefficient Ψ	Black women (n=139) coefficient Ψ	Asian women (n=114) coefficient Ψ	Hispanic women (n=167) coefficient Ψ
Intercept	-2.0756	-0.0214	6.6116	-13.4089	0.1347
Prepregnancy weight	0.6657 ‡	0.5986 ‡	0.5050 ‡	0.9273 ‡	0.6559 ‡
Delivery weight minus baby	0.3620 ‡	0.4654 ‡	0.4668 ‡	0.0426	0.3708 ‡
Maternal height	-0.0038	-0.0336	-0.0521	0.1692 €	-0.0335
Rank Ω	0.0230	0.0306	0.0861	-0.2917 *	0.0013
Income [a]	-0.0006	-0.0002	0.0003	-0.0024 *	-0.0010
Income squared	0.000000031	-0.000000023	-0.000000226	0.000000349 *	0.000000214
Education	-0.0978	-0.0241	-0.6976	-0.1787	0.6232
Parity	0.5482 †	0.3375	0.6032	1.5273 †	0.9211
Maternal age	-0.0253	-0.0349	-0.0173	0.0020	-0.0009
Married/Partner	0.2598	0.1844	2.2291	-4.7403 †	2.7368 *
Baseline depression	0.0503 †	0.0270	0.0983	0.0833	0.0847
Social support	2.3724 €	2.0733	5.5175	-0.1616	-0.1648
Social support squared	-0.6530 €	-0.4767	-1.2378	-0.2998 €	-0.2507
Black	0.3716				
Asian	0.0042				
Hispanic	0.2552				
Time since birth §	0.0003	-0.0244	0.0032	0.0633	0.0076

** Compared to white women

Ψ Modeling postpartum weight (kg)

Ω Participants rank if active duty, otherwise spouse's rank

[a] Average monthly household income

§ Time is measured in weeks

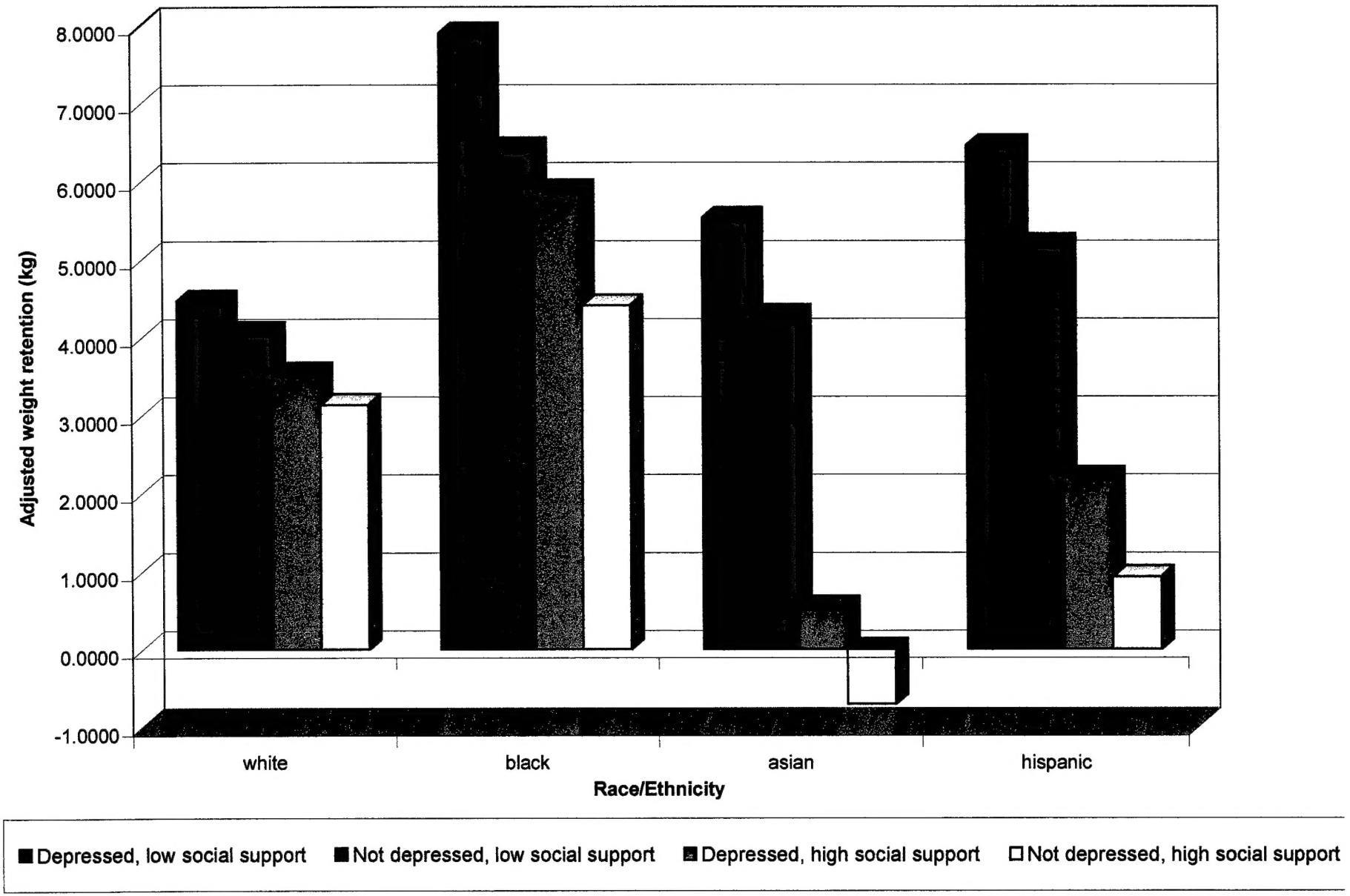
*p-value<0.1

€ p-value<0.05

† p-value<0.01

‡ p-value<0.001

Figure 19. Weight retention in four race/ethnicity groups, by depression and social support



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Prenatal and postpartum maternal body mass changes

Barbara F Abrams, DrPH, RD[1], Lee Ann Prebil[1], Steve Selvin, PhD[2], and Mi Suk Kang[1]. (1) School of Public Health, Division of Public Health Biology and Epidemiology, University of California, Berkeley, 140 Warren Hall, Berkeley, CA 94720, (2) School of Public Health, Division of Biostatistics, University of California, Berkeley, 140 Warren Hall, Berkeley, CA 94720

We followed a population of new mothers whose infants received well-baby care at Balboa Hospital, Naval Medical Center, San Diego to assess changes in maternal body weight during pregnancy and up to 6 postpartum visits during the baby's first year. We measured postpartum weight and height and obtained information on prepregnancy weight, gestational weight gain, and maternal social and behavioral characteristics by questionnaires and medical record abstraction. In all, we collected data from a racially diverse study sample of 2908 women, who provided data at up to 7 different postpartum time points. We present here a series of cross-sectional assessments of maternal body mass index (BMI=weight/height2) prior to pregnancy, at delivery and at 3 days, 10 days, 2,4,6,9 and 12 months postpartum. Mean body mass index prior to pregnancy ranged from 22.0 for Asian women to 25.0 for African American women. Gestational weight gain did not vary substantially by ethnic group, and all groups showed a decrease in body mass over the 1-year follow-up. However, it appeared that body mass remained higher, compared to before pregnancy, for African American, Hispanic and Native American women, than for white or Asian women. Postpartum body mass at different infant ages also differed according to active duty military status, frequency of exercise postpartum, cigarette smoking, breastfeeding, prepregnancy BMI, gestational weight gain, marital status, age, parity and economic sufficiency. These findings suggest different risk profiles for postpartum weight retention that may be useful in designing interventions to reduce the prevalence of obesity associated with childbearing.

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Abstracts of papers presented at the Thirteenth Annual Meeting, Seattle WA, USA, June 2000

**denotes person presenting the paper*

Black-white differences in postpartum weight loss

MJ Kang, B Abrams, S Selvin*

(University of California Berkeley School of Public Health)

Previous research has shown increased risk of postpartum weight retention for African-American women compared to White women, but little is known about the factors contributing to this difference. The authors studied a population of new mothers whose infants received well-baby care at Naval Medical Center, San Diego to answer two questions: Does a black-white difference in postpartum weight retention exist in this population? If so, does active duty status modify that relationship? Modification might be expected because active duty service women are required to maintain a level of physical readiness defined in part by standards of weight for height. Women were weighed, and data were collected via self-administered questionnaires and medical record abstraction. Data on postpartum weight retention at 10–24 months were analyzed for 496 adult women (404 White, 92 African-American) with a normal prepregnancy body mass index (19.8–26) who delivered infants of normal birthweight. Postpartum weight retention was examined using logistic and linear regression as well as multivariate analysis of variance in both the overall sample and stratified by race and active duty status. The mean weight retention was 5.2 kg (sd = 6.7) for black mothers and 2.7 kg (sd = 5.9) for white mothers. Thirty-one percent of the white mothers, and 51% of the black mothers retained $\geqslant$ 4.5 kg. After adjustment for 7 potentially confounding variables, using various multivariate techniques, black women were more likely to retain weight than white women. In models considering a race and active duty interaction, there was no racial difference in weight retention for active duty mothers, but the difference persisted for nonactive duty women. These results suggest that factors related to active duty military service, such as required physical activity and training, might help to explain the black-white difference in postpartum weight retention.